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FIRST ANNUAL REPORT
OF THE
CHIEF EXECUTIVE
VITICULTURAL OFFICER
TO THE BOARD
OF STATE VITICULTURAL COMMISSIONERS
1881.

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Chas. A. Wetmore

FIRST ANNUAL REPORT

OF THE

CHIEF EXECUTIVE VITICULTURAL OFFICER

TO THE

fornia.

BOARD OF STATE VITICULTURAL COMMISSIONERS,

For the Year 1881.

OFFICE, - - - - 111 LEIDESDORFF STREET,
San Francisco, California.

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To the Board of State Viticultural Commissioners:

Gentlemen: I have the honor to submit the following report, with the accompanying papers constituting Appendices A, B, C, and D, giving therein a brief summary of the work of my office during the past viticultural season, together with translations and original documents which contain information of special interest to those engaged in viticulture. It has been impractical, owing partly to the pressure of correspondence, and the inadequacy of the funds at the disposal of the State Printer, to prepare for publication more extended papers relating to the subjects treated, or treatises upon other important topics not yet touched upon.

Respectfully yours,

CHAS. A. WETMORE,
Chief Executive Viticultural Officer.

San Francisco, December 22, 1881.

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FIRST ANNUAL REPORT

OF THE

CHIEF EXECUTIVE VITICULTURAL OFFICER.

The work of this office comprises: first, original investigations of the present condition of the viticultural industries of the State; second, experimental demonstrations, both in the laboratory and the field; third, the dissemination of useful information; fourth, the declaration and enforcement of quarantine rules for the protection of viticulture.

To fully satisfy public demands and necessities will require patience, assiduity, persistence, ample funds, and continued efforts. The State has been liberal in its appropriations, but when we reflect that our people have launched themselves fearlessly upon the broad ocean of a vast industry, with little experience to guide them, and are in present need of all the information that the world has to give to assist them, we find that what is most wanted at the present time is a compilation of the knowledge which has been acquired by centuries of experience in other countries; most of which is attainable only through the medium of carefully digested translations from published works, written in languages with which our people are generally not familiar. Very few have even a slight conception of the great mass of information that might be collected from existing publications, or even of the great variety and value of current literature bearing upon the subjects, which may appear to them absolutely new to research. It is mortifying to know that so much exists within our reach, which would, if seized upon, constitute a vast treasure house for our people at this critical time, and which we are prevented from grasping for want of sufficient resources of time, labor, and public funds available for the purpose.

The new questions, especially those relating to diseases of the vine and means of protection, occupy so much of our time and our State appropriations that little is left for gathering together and publishing the general information necessary to success in the ordinary details of the industry. The magnitude of the favorable opportunities offered now and embraced by our people with their characteristic fearlessness, assumes such proportions of grandeur that it appears to be a gigantic folly to hesitate to give, through munificent appropriations, all the support that is necessary to enable inexperienced citizens an opportunity to compete, on equal terms, with all the world. What has become, through generations of effort and study, the property of other nations, should be, by one great and comprehensive effort of our State, purchased, so to speak, as a working capital for us to start upon. True statesmanship demands, in this respect, a complete work, so that while we may be forced into the study and discussion of the current questions of our own time, we do not suffer for lack of that which has been learned in the past.

It had been the intention of this office to draw heavily upon the standard French, German, Portuguese, Spanish, and Italian authorities, upon English chemists, and upon both English, American, French, and German scientists for compilation of information concerning ampelography or the species and varieties of the vine, adaptation, soils, culture (especially pruning, concerning which volumes have been published), raisins, fermentation, cooperage, distillation, machinery, hygiene, and commercial tendencies; but, in practical work, we find that the details of correspondence concerning the most primitive questions and conflicts of opinions, and the besetting and pressing troubles of our present though small development of viticulture, and the necessity of working within inadequate appropriations both for our own work and that of the State Printer, consume fully our resources of time, labor, and public funds.

ORIGINAL INVESTIGATIONS.

Concerning original investigations, we are almost destitute of aid in purely scientific research. Our efforts have been mainly in determining roughly the extent to which our vineyards are affected by diseases already known and described.

When this Commission was organized, it was known that the dreaded phylloxera had accomplished some destruction in the vicinity of Sonoma; beyond that it was not generally believed to exist in the State. Our first effort was to ascertain the truth and to determine the magnitude of the difficulties surrounding us. The selection of Mr. F. W. Morse, as a special investigator, to make rapid excursions and examinations of vineyards, has resulted in the greatest good that we have so far accomplished. We have been able to outline the progress of the pest, to locate its breeding grounds, to warn the public in time, and to obtain a sure foundation on which to base from year to year our observations of the rapidity of its progress. Thus we can estimate the danger, guard against it, and perhaps remove it entirely.

The limited time during which the pest may be easily detected and observed in each year has been one obstacle to our work, but we are happy to say, to the credit of Mr. Morse, that by strictly following his instructions, he has done remarkable work. We have found breeding grounds of the pest in Sonoma, Napa, Solano, Yolo, Sacramento, San Joaquin, Placer, El Dorado, Amador, Tuolumne, and Santa Clara Counties. In some of these the disease is scarcely perceptible, but its presence being ascertained, and being unable to say that it has not commenced its work elsewhere, we have been justified in arousing a general feeling of suspicion. The importance of being prepared to meet the approach of disease, which is imminent everywhere, is now fully realized, and when it comes only the negligent need suffer seriously.

Some vine growers have not well understood the instructions under which Mr. Morse has so rapidly traveled through their vicinity, and have been offended because his visits were so brief and without apparent value to them. It is therefore necessary to inform them that his efforts were not directed towards obtaining exhaustive results in each vineyard, which, although it would have been valuable, would have been impracticable for want of time. In Placer County, for instance, it is sufficient for our present purpose to outline the prominent appearance of the pest; this being done, the self-interests of the vine growers of that county should teach them to organize and complete the work by means of local efforts supported through local associations. To accomplish what some have expected, would have required us to send an investigator into each county, the expense of which would have more than exhausted our entire funds.

The details of Mr. Morse's reports are too voluminous for this publication, but are preserved in this office for public use when required, and for constant reference. During his examinations, which, under the urgency of the existing necessities, were directed mainly to the discovery of traces of the phylloxera, many indications of well known and sometimes apparently new forms of fungoid diseases were found and reported. Unfortunately, we have no expert at our service, either in public or private capacity, who can fully investigate for us these troublesome evils, and we therefore for the present can only warn vine growers, and especially those planting new vineyards, against the introduction of new fungoid germs, which they may greatly prevent by proper and effective disinfections. In future, we hope to be able to give more satisfactory information on this subject.

During the investigation this season, the time for operation passed before the work could be completed, and nothing was done in the southern counties.

EXPERIMENTAL WORK.

The experimental work has been conducted both in the laboratory and in the field. This has been principally devoted to:

First—Determining the relative effects of insecticides upon the living phylloxera, and upon the cuttings or vines to be affected by treatments.

Second—Determining the nature of and cost of procuring such insecticides.

Third—Practical demonstrations in the field of insecticidal treatments.

Fourth—Practical demonstrations with fertilizers and investigations as to the means of procuring them.

Fifth—Cultivation and propagation of American vines, resistant to the phylloxera.

In this branch of our work we have had too little time to note many results. The appropriations for our use did not become available until July 1, 1881, and even then we were embarrassed by the want of funds in the State Treasury, which compelled us to pay for services with warrants, which each claimant could utilize only by having the same discounted at a private bank. Our investigator, Mr. Morse, our Secretary, and myself have been obliged to advance funds continually, on which, in repayment, we have been subjected to losses by discounts, for which no allowance is permitted by the State Board of Examiners—to all of which we enter this form of protest rather than to make up the losses, as too many are ready to suggest to us, by fictitious bills for hair brushes and postage stamps. We refer to this parenthetically, because the law which does not protect against the inducement to render false accounts is a defective one. It is true that we might refuse to work and expend money until the treasury can pay the warrants drawn upon it, but the State would not forgive such inaction; if, therefore, it expects action, it should provide means to pay for its own delinquencies.

EFFECT OF INSECTICIDES ON ORDINARY AND ROOTED CUTTINGS.

In anticipation of the use of insecticides for the disinfection of ordinary and rooted cuttings, we commenced a series of experiments last Winter, making use of such available materials as then suggested themselves in order to test the resistance of such cuttings and roots to the effects of disinfectants. After treating the cuttings and roots, as if for the purpose of disinfection, each lot was labeled, a record kept of the nature of the treatment, and they were then planted in nursery without irrigation. These experiments were, however, necessarily crude, and not as comprehensive as they will be in future. We learned, however, that ordinary cuttings may be immersed in a powerful solution of bluestone for a long time—even exceeding twenty-four hours without destroying vitality—while rooted cuttings cannot safely be so treated. In every case, when a rooted cutting was treated to bluestone longer than half an hour, the plants all died, and even shorter time is dangerous to their vitality. Cuttings, however, appeared to be stimulated by the influence of the treatment. Immersing both cuttings and rooted vines in pyroligneous acid, strong solution of carbolic acid and other substances up to forty minutes did not injure them. They survived also a treatment with the vapors of sulphide of carbon.

We could not at that time obtain any sulpho-carbonate of potash to experiment with. The soluble phenyl was not then known to us.

During the Summer our Secretary has devoted a large part of his time to experimenting upon samples of roots infected with live phylloxera, which we procured from time to time, in quantities sufficient for the purpose of making complete and satisfactory demonstrations. The results have shown that a saturated solution of bluestone is unreliable; that sulphide of carbon for the purpose of such disinfection is only reliable when all the appliances are perfect; and that the most easily applied disinfectants, prompt in action, and least to be feared, as to effects upon the cuttings and roots, are the sulpho-carbonate of potash, and the preparation known as Little's soluble phenyl. Other compounds analogous to the latter may be procured, but are not available for general use in simple form.

In order to experiment with the sulpho-carbonate of potash, which is used extensively in France against the phylloxera, our Secretary was compelled to manufacture in the laboratory a small quantity to work with. None could be procured from the druggists. Subsequently, at our suggestion, he was induced to prepare apparatus for its manufacture, so that it might be procured when needed by the public, which he has done, as he heretofore accomplished the wish of this Commission in establishing a factory for the production of the bisulphide of carbon. This I especially refer to, because there are a few evil-minded, or, as I should say, small-minded persons who, not appreciating such good services, and because such commodities become necessarily objects of commerce, are mean-spirited enough to imagine and circulate their opinions that our recommendations of certain products are matters of self-interest. The most offensive of such criticisms has come from a wealthy man in Napa County, who happens to own a vineyard where we were so unfortunate as to find the phylloxera, and who, instead of attempting to extinguish the pest, complained because his agent had done so during his absence, and abused us for daring to say that his vineyard was infected. We have known a man to try to knock another down for telling him to "wipe off his chin;" but he would have been inexcusable if his chin actually needed such cleanly operation, and could scarcely have complained even if his friendly advisor offered to tell him where to buy a handkerchief. It is probably undignified to refer to such coarse and brutal criticisms; but whenever public sentiment shall become so corrupted that honest gentlemen cannot occupy positions of public trust and confidence without suffering from such barbarous and brutal assaults and without the privilege of reply, I shall be the first to decline to serve the public in any capacity; and I make this simple declaration for the benefit of a few others who have, in a small way, attempted to injure the good reputation of members of this Commission.

Some of the Results of the Experiments made by our Secretary were as follows:

Substance Used.	Strength of Solution, etc.	Time of Immersion.	When Examined, after Immersion.	Results Observed.
Sulphate of iron	1 ℔ to gallon of water	10 minutes	3 days	Insects alive and active.
Sulphate of iron	1 ℔ to gallon of water	20 minutes	3 days	Nearly all alive and active.
Sulphate of iron	1 ℔ to gallon of water	30 minutes	3 days	Alive and active.
Sulphate of iron	1 ℔ to gallon of water	50 minutes	4 days	None to be found.
Sulphate of iron	1 ℔ to gallon of water	50 minutes	2 days	Alive; none to be found in twelve days.
Sulphate of iron	Saturated solution	1 hour & 30 minutes	2 days	Dead.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	10 minutes	1 day	Alive and active.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	10 minutes	3 days	Alive and active.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	20 minutes	3 days	Somewhat reduced, but many alive and active.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	30 minutes	3 days	Alive and active.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	50 minutes	4 days	None to be found.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	50 minutes	2 days	Alive and active.
Sulphate of copper—Cu,SO_4	1 ℔ to gallon of water	50 minutes	12 days	None to be found.
Sulphate of copper—Cu,SO_4	Saturated solution	1 hour & 30 minutes	3 days	Alive and active.
Pyroligneous acid	1 part water	10 minutes	16 hours	Alive and active.
Pyroligneous acid	1 part water	10 minutes	2 days	Alive and active.
Pyroligneous acid	3 parts water	10 minutes	16 hours	Alive and active.
Pyroligneous acid	3 parts water	10 minutes	2 days	Alive and active.
Pyroligneous acid	10 parts water	10 minutes	1 day	Alive and active.
Pyroligneous acid	20 parts water	10 minutes	1 day	Alive and active.
Pyroligneous acid	Pure	10 minutes	3 days	Nearly all dead.
Pyroligneous acid	1 part water	20 minutes	3 days	Alive and active.
Pyroligneous acid	Pure	15 minutes	3 days	Roots rinsed after immersion—alive and active.
Pyroligneous acid	Pure	15 minutes	4 days	None to be found.
Pyroligneous acid	3 parts water	50 minutes	1 day	Alive and active.
Pyroligneous acid	3 parts water	50 minutes	12 days	Dead.
Pyroligneous acid	3 parts water	50 minutes	1 day	Appearing dead.
Little's Soluble Phenyl	Solution 1 to 50	10 minutes	1 day	All dead.
Little's Soluble Phenyl	Solution 1 to 50	10 minutes	3 days	Dead and decomposing, odor of phenyl still noticeable.
Little's Soluble Phenyl	Solution 1 to 100	10 minutes	12 days	Dead.
Little's Soluble Phenyl	Solution 1 to 50	1 minute	12 days	None to be found.
Little's Soluble Phenyl	Solution 1 to 50	1 minute	2 days	Alive.
Little's Soluble Phenyl	Solution 1 to 100	10 minutes	2 days	Dead.
Little's Soluble Phenyl	Solution 1 to 100	5 minutes	2 days	Part alive; part dead.
Little's Soluble Phenyl	Solution 1 to 50	5 minutes	2 days	Dead.

Little's Soluble Phenyl	Solution 1 to 25	5 minutes	2 days	Dead.
Little's Soluble Phenyl	Solution 1 to 10	1 minute	2 days	All appear dead.
Little's Soluble Phenyl	Solution 1 to 10	20 seconds	2 days	Nearly all dead—some life remaining.
Little's Soluble Phenyl	Solution 1 to 5	Dipping momentarily	2 days	Dead.
Bisulphide of carbon—C,S_2	Saturated vapor	10 minutes	1 day	Alive and active.
Bisulphide of carbon—C,S_2	Saturated vapor	20 minutes	3 days	Trace of life remains.
Bisulphide of carbon—C,S_2	Saturated vapor	30 minutes	4 days	All dead.
Bisulphide of carbon—C,S_2	Saturated vapor	30 minutes	2 days	Dead.
Bisulphide of carbon—C,S_2	Saturated vapor	30 minutes	12 days	Dead.
Bisulphide of carbon—C,S_2	Saturated vapor	30 minutes	1 day	Appear dead—eggs shriveled.
Carbolic acid	1 ℔ to 20 gallons	30 minutes	3 days	Dead, though not decomposed.
Carbolic acid	1 ℔ to 20 gallons	15 minutes	4 days	None to be found.
Carbolic acid	Sat. sol. diluted 1 to 25	10 minutes	12 days	Dead and mouldy.
Carbolic acid	Sat. sol. diluted 1 to 50	20 minutes	12 days	Dead and decomposed.
Carbolic acid	Sat. sol. diluted 1 to 100	50 minutes	2 days	Dead.
Carbolic acid	Sat. sol. diluted 1 to 50	10 minutes	2 days	Dead.
Tobacco decoction	Boiled 1 hour in 20 parts water & standing 2 days	30 minutes	3 days	Alive and active.
Tobacco decoction	Boiled 1 hour in 20 parts water & standing 2 days	50 minutes	4 days	None to be found.
Tobacco decoction	Boiled 1 hour in 20 parts water & standing 2 days	50 minutes	2 days	Alive and active.
Tobacco decoction	Boiled 1 hour in 20 parts water & standing 2 days	50 minutes	12 days	Alive and active.
Bisulphide of carbon water	Dissolv'd in water 3 days	50 minutes	4 days	All dead and decomposing.
Bisulphide of carbon water	Standing 6 days	50 minutes	2 days	Dead.
Bisulphide of carbon water	Standing 6 days	30 minutes	2 days	Dead.
Bisulphide of carbon water	Standing 6 days	30 minutes	2 days	Dead.
Sulp'o-carbonate of potassium-K_2,CS_3	Pure solution	10 minutes	4 days	None to be found.
Sulp'o-carbonate of potassium-K_2,CS_3	1 oz to 1 gallon of water	20 minutes	12 days	Dead and decomposed.
Sulp'o-carbonate of potassium-K_2,CS_3	1 oz to 1 gallon of water	10 minutes	12 days	Dead and decomposed.
Sulp'o-carbonate of potassium-K_2,CS_3	1 oz to 1 gallon of water	10 minutes	2 days	Dead.
Carbonate of potash—K_2,CO_3	1 ℔ to 1 gallon	10 minutes	12 days	Alive and active.
Carbonate of potash—K_2,CO_3	1 ℔ to 1 gallon	20 minutes	12 days	None found.
Carbonate of potash—K_2,CO_3	1 ℔ to 1 gallon	20 minutes	2 days	None found.
Sulphide of potassium—K_2S	1 oz to 1 gallon	20 minutes	12 days	None found.
Sulphide of potassium—K_2S	½ oz to 1 gallon	50 minutes	2 days	Dead.
Sulphide of potassium—K_2S	1 oz to 1 gallon	20 minutes	1 day	Appear dead.
Common washing soap	1 ℔ to 10 gallons	30 minutes	1 day	Alive and active.
Common washing soap	1 ℔ to 10 gallons	50 minutes	1 day	Alive.

In addition to the above experiments, which were by immersing infected roots in solutions of substances with water in all cases, except where vapor of bisulphide of carbon was used in closed vessels, the following experiments were tried upon infected roots buried in pots filled with earth:

One third of a pound of sulphate of copper (bluestone) per gallon of water was applied in pot, in proportion of one gallon of solution to cubic yard of earth. Examined after three days, no diminution of phylloxera was observed.

A solution of Little's soluble phenyl, one to fifty, was filtered through a pot filled with earth; the resulting fluid permitted to clear and then tested as insecticide. Infected roots immersed twenty minutes; after two days, insects alive and active. Ten minutes' immersion, same result. Infected roots were placed in pot and buried with earth; watered with solution one fluid ounce, ten of water plus a half pint of water; in four days examined, insects dead. Weaker solution ineffective.

The sulphide of carbon we do not recommend for the disinfection of cuttings, because to obtain a perfect application requires the use of specially prepared tight apparatus, and by reason of the gaseous nature of the substance when evaporating, the full extent of its influence cannot practically be determined by the ordinary farmer. Insecticidal solutions are more simple, and the regularity of applications is more easily controlled by them.

Concerning the sulpho-carbonate of potash, special information is obtained in Appendix C, to this report, prepared by our Secretary, Mr. J. H. Wheeler, who is a specialist in that line.

The Little's soluble phenyl is worthy of extended and continued experiment. We learn that it is a combined product of certain distillations from coal tar and resin, mixed with oleate of potash and caustic soda. It has been used antiseptically in the Massachusetts General Hospital, under the service of H. H. A. Beach, M. D. In the report this year of surgical cases treated antiseptically, reference is made to this phenyl as a "new disinfectant," which was found by analysis to contain less than one per cent. of carbolic acid, and "between eighty and ninety per cent. of a high boiling tar oil—probably 'dead oil,' whose most prominent component is napthaline, and which of itself contains little or no phenol (carbolic acid). The emulsifier is probably a potash soap, or something closely allied." It was found in the hospital service that the small quantity of carbolic acid contained was not sufficient to explain its antiseptic properties, "which appear equal to those of carbolic acid, more powerful than boracic acid, and are protective for a longer time than thymol." It was found to be harmless in handling, and superior for this reason to carbolic acid.

Coal tar and its oils have been used in many forms in France for washing vines, to kill the Winter egg of the phylloxera and other pests—generally united with potash; but this phenyl comes in such convenient form, and is so easily prepared for use, that it will probably be preferred to any similar compound, which must be manipulated more before application. I am of the opinion that among the many uses to which it may be put, will be washing vines after pruning, to destroy germs of fungus, and watering the soil around young vines to keep off the attacks of the cut worm. This, like the sulpho-carbonate of potash, becomes a fertilizer, when applied to the soil.

Bluestone was found wholly unreliable as a disinfectant against phylloxera. Sulphate of iron is to be preferred when the wash is used to destroy fungoid germs. Washing vines with the latter may become a regular practice, fertilizing or stimulating the vine, while protecting it from disease. This substance is moreover much cheaper than the sulphate of copper (bluestone).

The recommendations of your Committee on Phylloxera, Vine Pests and Diseases of the Vine, and the quarantine rules now in force, were based upon the results of these experiments, which, however, are not considered completed yet. We have ascertained sufficient, however, to be satisfied that cuttings and rooted vines may be safely and well disinfected at small cost, and with great ease, by the use of either the sulpho-carbonate of potash, or Little's soluble phenyl, sufficient margin of time during immersion being given to provide for killing the egg of the phylloxera, or the germs of fungus. Other methods tried, though effective, were less satisfactory in point of cheapness, ease of execution, or absolute safety to the cuttings or roots treated.

Other experimental work of a varied character has been conducted in the laboratory, but results are thus far not complete, or not sufficiently important for a detailed report.

PRACTICAL DEMONSTRATIONS IN THE FIELD.

In order to test practically the best known remedies for the protection of vineyards against phylloxera, we selected a small infected vineyard in the Sonoma Valley—small enough for our purpose and so detached as to enable us to work to advantage. It is the property of Mr. H. Appleton, being the relic of a once large vineyard. We obtained the privilege of treating this place, as we should desire, in any form of experiment, and also extended our work of experiment and observations into a portion of an infected vineyard on the opposite side of the county road. The plan of the field accompanying this report illustrates the method we have pursued.

The plan indicates, by the intersection of lines, the positions of vines, and by conventional marks, the position and number that were found to be diseased, killed by phylloxera, killed in previous cultivations, or injured by cultivation. This was first ascertained by careful examination as a basis for further operations, so that the progress, or checking of the pest, and also the effect of fertilizing upon the sick vines, might be accurately noted. The rows of vines in transverse directions were so lettered and numbered that the exact position of any given vine might be at any time determined and referred to.

The treatment with bisulphide of carbon and fertilizers was begun after vegetation had advanced considerably in order to fully test the efficacy of summer treatments. The plan indicates, by shaded plats, referred to by number in the margin, the kinds of fertilizers that were used on the several parts—parts not shaded having received no such amendment, but subjected to the bisulphide treatment alone. Fertilizers were applied in liquid state. All the plats, A, B, C, D, and E, were treated with the insecticide. That part of plat F, in which the ravages of the insect had been noted, was left undisturbed as a test of the progress of the disease when left to itself.

The result of the season's work was only satisfactory as a demonstration of negative principles, excepting that the effect of the bisulphide was shown in practically annihilating the pest in the parts treated, and in insuring an increased crop. Notwithstanding the fact that this vineyard is below the average in fertility of soil, and that the average crops of the valley were much less than during the preceding year, this place yielded two tons more of grapes than in 1880. This good result must have been due to the bisulphide of carbon, which destroyed the insects upon the roots, and not to the fertilizers, because by comparing the parts fertilized with those not so treated no appreciable advantages could be observed. It is apparent that fertilizing in the dry Summer time, even with liquid compounds, unless the quantity of water used is great enough to penetrate deeply and to maintain moisture, is nearly useless for the season during which it is practiced.

The bisulphide treatment in Summer is proved to be too-tedious and expensive, notwithstanding some good results. The ground being hard, it was difficult to make the holes for the insertion of the injector, and the surface being dry and more or less cracked, or open to the atmosphere, prevented the vapors from thoroughly accomplishing their purpose upon the infected surface roots. Near the surface the vapors became mixed with air and ceased to have complete toxic effects. However, to experiment still further the extra third surface treatment was made, after it was discovered that in a few places the insects still could be found on the same roots. This, for a time, appeared to have accomplished all that could be desired, and no trace of the pest was found again until much later in the season, when again a few surface roots were found infected.

It was demonstrated by these experiments—

First—That the bisulphide of carbon could be relied upon in curative or periodical treatment to destroy the greater part of the phylloxera without injuring the vines, even in Summer time.

Second—That such treatment enabled the sick vines to recuperate and to increase in fertility.

Third—That a successful periodical treatment is possible.

Fourth—That Summer treatments are very expensive and not as satisfactory as in Winter.

Fifth—That Summer fertilizing in dry ground without a sufficiency of water, is useless for the season when practiced.

Sixth—That this treatment may well be recommended in special cases, where the pest is first discovered during the growing period, and when it is desired to prevent its multiplication while waiting for the more certain Winter treatment.

During the coming Winter months a complete Winter treatment will be made, and more effective fertilizing will be tried. The materials for the latter will be suint (containing nitrogen, phosphoric acid, and potash), superphosphates, potash, and sulphate of iron. It is our intention to ascertain in this report whether it is practicable to restore a badly infected vineyard which lies within a seriously infected district. The report of our Secretary, accompanying this paper (See Appendix C), contains further mention of this experimental work.

Efforts have been made again this year to ascertain the presence of the winged female phylloxera above the soil, but they have failed as before. We are forced to believe that this form of the pest does not appear in formidable numbers, which probably is the reason to account for the slow progress of the disease in this State. We have examined many roots during our experiments in testing insecticides, but have only rarely seen the winged female. From this we presume that the pest may be easily circumscribed and annihilated, if energetic measures are adopted. The Winter egg is not much to be dreaded, because this apparently is not laid above ground, at least not in great numbers. In Appendix A will be found a brief resume of the life history of the phylloxera, which will explain the reference to the Winter egg, as it appears to be found in France, and on vines east of the Rocky Mountains.

FERTILIZERS—HOW TO PROCURE THEM.

Healthy vines require more or less fertilizing, the chief elements to be applied being phosphoric acid, potash, and nitrogen. Sulphates, and especially sulphate of iron, appear to be very valuable as stimulants.. One of the most available materials for our vine-growers is the refuse of wool washing, called *suint*, which can be obtained in large quantities in San Francisco. This material contains shreds of wool, fatty oils, rich in phosphoric acid, potash, and a large proportion of waste organic matter. One analysis made by Mr. Edward Booth showed that the sample contained:

Water	7.19		7.19
Ash	53.34	Phosphoric acid	.61
		Potash	2.55
		Sand, iron, etc	50.18
Oil	11.33	Nitrogen	4.98
Wool, etc	28.14	Other organic matter	34.49
	100.00		100.00

Or, one ton of suint, such as sample, contains:

Water	143.80 pounds.
Phosphoric acid (P_2O_5)	12.20 pounds.
Potash (K_2O)	51.00 pounds.
Sand, iron, etc	1,003.60 pounds.
Nitrogen	99.60 pounds.
Other organic matter	689.80 pounds.
	2,000.00

The following are the approximate values of the leading fertilizing elements in the New York market: nitrogen, per pound, eighteen cents; phosphoric acid, per pound, five cents; potash, per pound, five cents.

This, at commercial rates, would make suint valued in New York at about twenty dollars per ton. In this State it has generally been left to waste, or thrown into the sea. It can be purchased cheaply and should be utilized. The slow decomposition of the wool in the soil renders the material more valuable and lasting; its effects will be noticeable for several years. In the work of Professor Foëx (see Appendix A), under the head of fertilizers, attention will be drawn to the value of woolen rags for dry southern French soils. Suint is preferable, having much soluble phosphoric acid and potash.

Sulphate of iron is to be recommended for two-fold advantages: First, it may be used in strong solution to wash vines after pruning, to destroy fungoid germs; and secondly, to stimulate vegetation.

Potash, other than is contained in suint, is not so easy to procure. Wood ashes are not generally preserved. But when demand comes for the material our clearings will probably afford an abundance.

Bones, horns, animal matter, leather scraps, etc., will furnish phosphoric acid, as well as more or less nitrogen. For immediate effect and thorough diffusion in the soil, bones and bone meal should be converted first into superphosphates, by means of sulphuric acid; the phosphate of lime becomes thereby soluble, and by action of rains distributed in the soil. Although it may again become insoluble, its diffusion will be of great advantage. Superphosphates may also be obtained from the sugar refineries, sulphate of ammonia, from the gas works.

The uses of the marc from the wine press, barnyard manure, etc., are fully set forth in the pages of Appendix A.

AMERICAN VINES.

The experiments made by us directly with American vines have been confined to the *vitis Californica.* We have planted seedling vines over the roots of old vines infested by phylloxera, without fertilizing or special care. One season is not sufficient to test results completely. Under the conditions in which they were planted only vigorous plants could have shown any progress, even in the absence of special disease. The tender roots were attacked by the pests, but late in the fall the plants were still flourishing, and showing no sickly appearance in foliage. One more season should give us more positive assurance of the resistance of this species.

Outside the work of the Commission we have watched with interest the experiments of many different growers in progagating different American species. In my own personal experience, propagating seedlings and rooting cuttings, I have very little to add to the information contained in the works of Professors Foëx and Millardet (See Appendices A and B). These matters, however, not being under my control, as your chief executive officer, I shall reserve discussion of them until I shall contribute to the regular annual reports of the Commission. Moreover, this office is now so overcrowded with work that I have not the necessary leisure for critical essays.

THE APPENDICES.

In compliance with the law under which I am governed, I have caused to be prepared Appendices A, B, and C, which contain most valuable instruction relating to the four leading methods of combating phylloxera. The *Practical Manual* of Professor Foëx, is also serviceable for those who plant the ordinary European cuttings, most that applies to the culture of the vine being equally applicable to them, as well as to those using American stocks. In this work I have been greatly assisted by my sister, Miss Anna Louise Wetmore, who has performed the laborious part of translating Appendices A and B from the French, and by our Secretary, Mr. J. H. Wheeler, who has prepared Appendix C, relating to bisulphide of carbon, and sulpho-carbonate of potash.

The greater part of the chapter on grafting American vines in the *Manual* of Professor Foëx, was given in the first annual reports of this Commission from an advance document. It is therefore not reproduced in this report.

The descriptions of tools and machines for grafting vines were very brief in the chapter on grafting in first annual report referred to, so I have reproduced the following translation from the work of Professor Foëx in this place:

GRAFTING TOOLS AND MACHINES.

A. *Tools for simple Cleft Grafting.*

For this operation are used: First, a saw with an iron bow, or a garden saw, for decapitating the large stocks; second, pruning shears for weaker stocks; third, an iron chisel, similar to a cold chisel, or better, a chisel in the form of a knife-blade, which offers the advantage of opening the vine more in front than at the center; fourth, an ordinary hammer, or, better still, a pick-hammer, which, while serving to drive in the chisel, permits of loosening the earth from the grafting stock if necessary; fifth, a pruning knife for making the cleft in young stocks, and also for preparing the grafts.

B. *Special Tool for Pontoise Graft.*

For this sort of grafting we often use a gouge, with an angular blade, which allows of making an acute incision in which the graft is lodged.

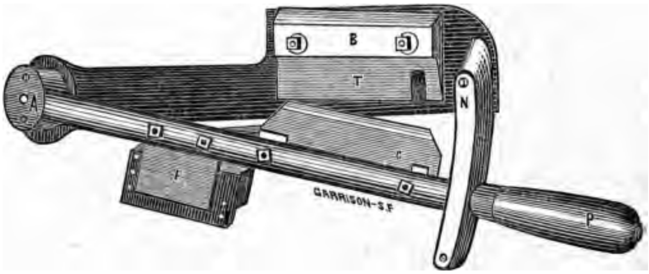
C. *Machines for English Cleft and Champin Grafting.*

The use of machines has greatly facilitated the application of grafting to the reconstitution of our vineyards; it permits employing for this work, hitherto reserved for special workmen, any day laborers, or even women; hence may be understood the ardor with which they have been received by viticulturists.

The most highly estimated and most used up to the present time, of the grafting machines, is Mr. Petit's. Here is an explanation of it given by Mr. Bréheret, of the Viticultural Station of Montpellier, in his report on the exhibition of tools and special machines for grafting the vine, organized at the National School of Agriculture at Montpellier, by the Central Society of Agriculture, Herault, the eighth, ninth, and tenth of March, eighteen hundred and eighty:

The grafting machine of Engineer Petit, of Langon (Gironde), is undeniably the first which, for some time now, has attracted the attention of viticulturists, and it is beginning to be quite well known by the agricultural public, who keep up with the progress in mechanical art, for whom there is no need of our stopping to give the smaller details of its construction and its manner of working.

FIG. 1.



Petit's Machine for the English cleft graft in workshop.

The Petit apparatus consists of two blades: One C, for beveling the cane, the other, F, for making the cleft, moved by a horizontal lever swinging about a fixed axis, A, and and guided by a slide in a frame N. The whole is attached to a casting which serves as a frame, and which is fastened to the edge of a table by means of a screw. The lever, and consequently the blades, have a horizontal reciprocating motion. A handle, P, which the workman works with his right hand, serves to set the lever and blades in motion. The blade C, which does the cutting, is situated on the right of the machine; the blade F, which makes the cleft, is very similar to the straight part of an ordinary pruning knife, excepting in size.

Under the first blade, C, is found a small table, T, which supports the cane while it is being cut. It consists of a vertical part, B (Fig. 2), which serves to keep the cane from slipping up out of place, and a doubly inclined surface, A, C, D, E, inclined from back to front, and from left to right serving to give the cane a suitable inclination with regard to the tool. In this part lies the main idea of the machine; it is the most important, hence the application of the same principle has since met with a certain number of imitators. The table is held in place by two little bolts sliding in grooves made in the table, which serves as a framework, and it is supported by four screws, which allow of regulating its position; it should be so arranged that when the lever is at the end of its course, the edge of the blade is even with the upper part of the inclined plane following the line A D.

FIG. 2.

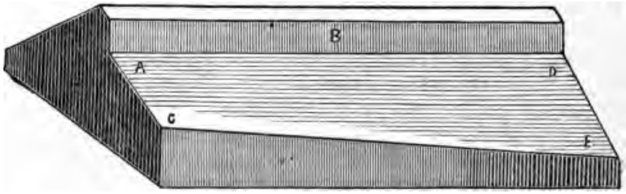


Table Casting for the Petit Machine.

To do the cutting, the workman brings the lever to him, and, holding the cane with the left hand, he rests it on the table perpendicularly to the butment; with the right hand he pushes the lever forward, and the blade cuts the cane neatly with the desired inclination. The further the cane is placed to the left, the longer will be the cut, so that cuttings of small diameter will be placed towards this side of the table, and the larger, on the contrary, towards the right. Therefore the cut may be of any inclination desired, and two canes of the same size, placed one after the other, at the same point on the table, will be cut with the same inclination, which is essential.

Under the left blade, F, is a support, S, analogous to the table we have just been speaking of, that is, its upper side presents an inclination from back to front, and from left to right. To make the cleft, the workman pushes the lever to the end of its course, places the cane on the support, cuts it above the center, so that the edge of the blade strikes the bevel at the point where the cleft is to begin, and draws the lever towards him until the work is done.

In the *Champin* graft, a blunt end is left; when it is desirable to execute it, it suffices to regulate the position of the table in lowering it until the blade strikes the butment a little above its line of union with the inclined surface.

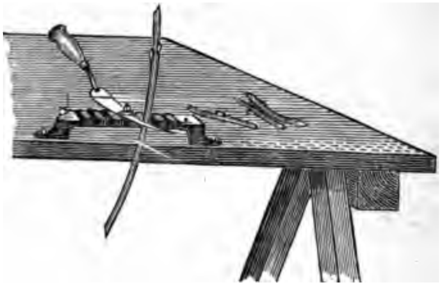
After a few hours of practice, a workman will soon be able to do the grafting with perfect execution.

Made for the purpose of grafting cuttings or rooted plants that have been dug up, the Petit machine, while doing excellent work, the success of which has already been pointed out during the campaign of eighteen hundred and seventy-nine, has the advantage of uniting many qualities indispensable to every agricultural implement; simplicity of arrangement and manner of working, solidity, and relative low price, since it is only thirty-five francs, and will be still lower. This machine, perfectly adapted to the functions which it is required to fulfill, is a simple tool in every sense of the word.

Mr. Berdaguer's machine is used also, which is certainly less perfect than the preceding, but which gives satisfactory results however, and whose lower price renders it accessible by the most moderate purses. In the report before mentioned, Mr. Bréheret describes and values it as follows:

> Another machine that made its appearance in our region at the time of the Viticultural Congress at Nimes, in September, 1879, is that of Mr. Berdaguer, *constructeur, rue Childe bert,* 17, *à Lyon* (Fig. 3.) It consists essentially of two blades, with inverted edge, and has a horizontal lever turning on a central axis, which is fastened to a metal plate in which are made six grooves of various sizes. The right blade serves to make the slanting cut, the left to make the cleft, and both are alternately worked by the reciprocating movement communicated to the arm of the lever which is a prolongation of the latter blade.
>
> A butment situated on the posterior edge of the right half of the instrument is destined to serve as a prop for the cane that is cut. Below the first blade, the right hand one, are found three cavities representing, in hollow form, the bevel of an English graft, and serving to protect that part of the cutting which should be taken care of. Under the left blade are three unequal grooves, in which is placed, according to size, the cut cane which has to be split. Then, too, in the thick part of the metal plate, there is a notch which acts as the hooked part of pruning shears, and which permits the grafter to cut a cane perpendicularly to its fibres.

FIG. 3.

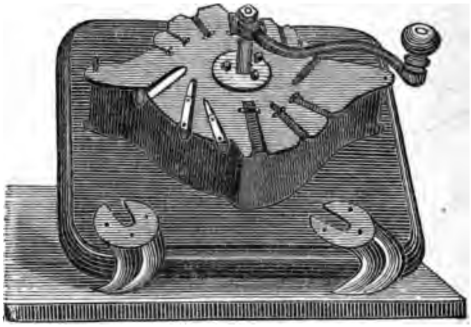


Berdaguer's Machine for the English cleft graft in workshop.

> In order to use the Berdaguer apparatus it must be very firmly fixed on the front edge of a table, by means of screws which are put in the holes used for this purpose. That done, the workman takes the little handle in his left hand; he pushes it forward, and, holding the cutting in his free hand, he introduces it in one of the cavities on the right; then drawing the arm of the lever towards him, the opposite blade advances, making the bevel.
>
> To make the cleft, the grafter a second time pushes the arm of the lever forward, and places the cut cane in one of the grooves on the left, holding it firmly. On its return the blade splits the cutting, and stops when the lever comes in contact with a small projecting screw which limits its backward movement. When the cutting is of small diameter the bevel is made at once; if it is large, we have the partial bevel of the Champin graft; but if it is desirable to have that of the English graft, it is only necessary to move the cutting nearer the butment, and a second cut suffices to obtain it.
>
> Much less complete than the Petit machine, but also much less costly, since its price is only twelve francs, this instrument is especially adapted to the grafting of cuttings. Removing the blades is very easy, for the whole machine is extremely simple.

Mr. Francois Sabatier, member of the Agricultural Society of Herault, has invented a new machine, destined to do the same work as the preceding ones (Fig. 4). This apparatus, which appears very well conceived, unfortunately is not yet in commerce, and, consequently, has not been practically tried up to the present time.

FIG. 4.



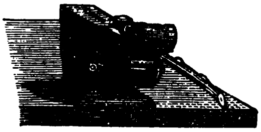
Mr. Francois Sabatier's Machine for English cleft graft in workshop.

D. Special Machines for the Execution of the Champin Graft.

Only one machine has been constructed, up to the present time, especially for the Champin graft;

it is that of Mr. Leydier (of Leucieux-Vaucluse), of which we give the following description, also taken from Mr. Bréheret's report:

FIG. 5.



Leydier's Machine for the Champin graft in workshop.

The principal parts of the Leydier apparatus are (Fig. 5): A middle blade, movable at will in making a reciprocating motion over a transverse axis, which is found at the middle of its length; second, a plate which moves by its posterior extremity in the same direction as the blade, and serves as a lower support for it; third, a regulator; and, fourth, a plane movable from front to back, which, at the same time, constitutes an upper support for the middle blade.

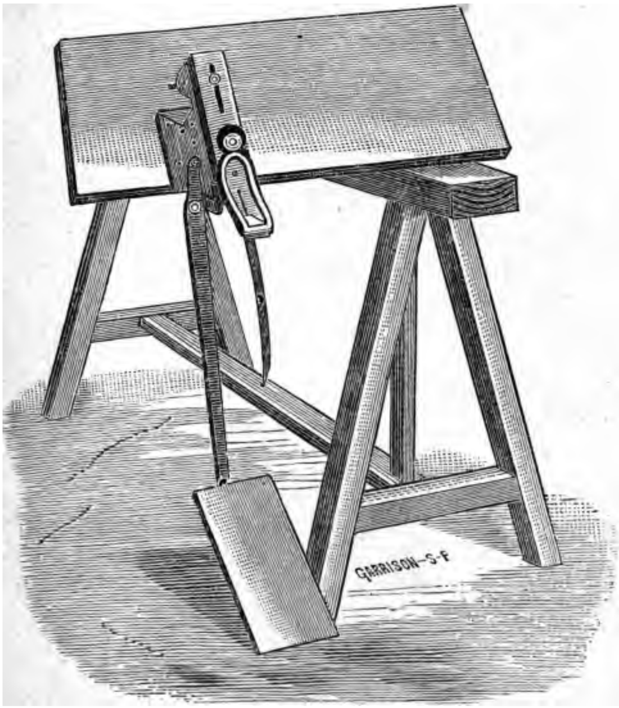
The distances between the blade and its two supports are regulated in such a way that between them and the plane there is always a space double that between it and the lower support, whatever may be the size of the cutting used.

The regulator is composed of a little lever and two pieces, rather similar in shape to the pistolets used by draughtsmen. These two pieces are joined, one to the blade, the other to the lower support, and, as the little lever passes between them with hard friction, its reciprocating motion determines openings proportionally invariable of two to one.

The plane is a large, horizontal, movable piece, which is found on the upper part of the instrument, and the blade of which, fastened by a screw, may be taken out at pleasure to be sharpened. It makes the bevel, and its blade, brought to the end of its course, is always even with the rotary axis of the middle blade, so that, however the diameter of the cutting may vary, the length of the bevel remains the same.

In its backward movement, the plane is guided by two grooves, one external, the other internal. In front of the latter, a leather thong is fastened to it and passes over a pulley situated at the back part of the instrument, terminating in a knife-grinder's treadle. Above the strap is a spring which is stretched out during action, and allows the tool to return to its former position when once the cutting is through with.

FIG. 6.



Leydier's Machine, mounted on table with pedal.

All these pieces are mounted on a metal frame which may be firmly fixed on the edge of a table, one of the planks of which is crossed by the leather strap (Fig. 6.)

To use this machine, the workman takes a cutting and tries to introduce it in the opening, where is found the blade we have spoken of. If the diameter of the cutting is too large or too small for this opening, with his left hand he works the regulator to produce the desired size. This done, he pushes the cutting in, which, coming in contact with the blade, is split exactly at the spot intended in the ratio of two to one, and, then pressing on the pedal, the plane moves backward, making a perfectly regular bevel.

The Leydier apparatus, although costing only twenty-five francs, is a machine that does great work, and one that every workman can use without any apprenticeship.

The divers machines we have just examined allow of doing the grafting only in the workshop. Although several machines have been proposed for working in the open field and on growing vines, none of them, up to the present time, seems to be sufficiently perfect for practical use.

QUARANTINE.

In conformity to the instructions of the Commission, I have declared, published, and circulated throughout the State quarantine rules and regulations, in the following terms:

Board of State Viticultural Commissioners,
Office of Chief Executive Viticultural Officer,
No. 111 Leidesdorff Street, San Francisco.

To all whom it may concern: Be it known, that I, Charles A. Wetmore, Chief Executive Viticultural and Health Officer of the Board of State Viticultural Commissioners, being duly authorized and instructed by said Board, do declare the following quarantine rules and regulations for the protection of the viticultural industries of this State; and due notice is hereby given, as provided by law, thirty days of publication in two daily newspapers of general circulation, not of the same city or county, in this State, and by posting notices in all counties affected by these rules. All parties concerned therein are required to conform thereto, subject to penalties provided for by law for any infraction or evasion of said rules and regulations:

QUARANTINE RULES AND REGULATIONS.

Rule 1. All cuttings of grapevines made in this State for sale, gift, or distribution outside of the vineyard or vineyards where the same were grown, and intended for new plantations, shall be made solely of the wood of the preceding year's growth; all older wood to be carefully and thoroughly removed before leaving the vineyard where made, and to be immediately destroyed by fire, if removed from such cuttings, wherever seized by any duly authorized inspector for any evasion or infraction of this rule. The reason for this rule is, that the Winter egg of the phylloxera vastatrix is, according to the best authorities, found only on the old wood.

Rule 2. All cuttings of grapevines, and rooted grapevines, imported from any region or country outside this State, intended for sale, gift, or distribution for plantation in this State, shall be disinfected at the place of first consignment within this State before being further distributed or planted, the method of disinfection to be at the option of the owner or agent in charge of the said cuttings or vines, according to any one of the following methods, viz.:

First—Dissolve sulpho-carbonate of potassium in cold water; proportions, ten pounds of sulpho-carbonate to one hundred gallons of water; immerse cuttings and rooted vines fifteen minutes.

Second—Dissolve Little's soluble phenyl by pouring upon it cold water in the proportion of fifty gallons of water to one gallon of the phenyl; immerse cuttings and rooted vines ten minutes.

Third—Take two parts heavy oil of coal tar, two parts water, and one part carbonate of potash or carbonate of soda; put in a covered vessel and heat gently to boiling point for one hour; replace water lost by evaporation; pour into suitable vessels and agitate violently; dilute with fifty parts of cold water; immerse cuttings and rooted vines ten minutes.

Fourth—Dissolve carbolic acid crystals in water, in proportion of one pound of acid to twenty gallons of water; immerse cuttings and rooted vines ten minutes.

Fifth—Dissolve sulphide of potassium in the proportion of one pound to twenty gallons of water; immerse cuttings and rooted vines twenty minutes.

Sixth—Dilute one part of "liver of lime" in twenty parts of water; immerse cuttings and rooted vines ten minutes. [N. B.—To make "liver of lime," take one pound quicklime, one pound sulphur, one gallon water; mix; boil over quick fire to one half of volume; agitate before using; dilute with twenty parts of water to one part of "liver of lime."]

Any other efficacious method may be used, provided due notice is given to this office and the same be approved.

INSPECTORS.

For the convenience and protection of all interested parties throughout the State, there will be appointed local resident Inspectors, as provided for by law, for each section or region where vine growers desire the same, and upon the application of any three such neighboring growers, or parties intending during the coming season to plant vines, such application to be addressed to this office, and to be accompanied, whenever practicable, with nominations of suitable persons for the office of Inspector. The other Inspectors required by law will be appointed by this office.

RECOMMENDATIONS FOR THE FURTHER PROTECTION OF VINEYARDS.

All persons planting new vineyards within the State are advised and strongly urged to consider all roots and cuttings suspected, regardless of origin, and to thoroughly disinfect them, thereby accomplishing the destruction of all possible germs of insect pests upon them, as well as also those of fungoid disease, which are becoming dangerous in all parts of the country.

CERTIFICATES.

For the further convenience of vine growers, certificates shall be issued by any Inspector residing near the vineyard of the applicant, or the person in charge of cuttings or rooted vines, setting forth that the provisions of Rule Two have been complied with, and shall be entitled to charge in each case not exceeding fifty cents for such certificates made out in duplicate, one certificate being sufficient to cover any quantity of cuttings or rooted vines in the possession of the applicant that may be satisfactorily shown to the said Inspector to have been disinfected. Certificates of disinfection shall likewise be given any applicant who desires the same, and who shall satisfactorily show to the Inspector that cuttings and rooted vines, other than such as are required to be disinfected by Rule Two, have been properly disinfected in accordance with the recommendations of this office.

INFECTED WRAPPINGS, ETC.

RULE 3. All packages and the packing materials coming into the State with imported cuttings and vines (referred to in Rule Two) shall be disinfected at the time of disinfecting the contents thereof, by immersing in or washing with any of the solutions named in Rule Two, provided that the strength of the same, in case of mere washing, shall be increased by the reduction of the water in the same to one fourth the relative proportions named. If not disinfected, such packages and packing materials shall be destroyed by fire.

PENALTIES.

All infractions or evasions of these rules will be punishable according to law.

CHAS. A. WETMORE,
Chief Executive Viticultural and Health Officer.

SAN FRANCISCO, November 16, 1881.

The list of Inspectors to be appointed is not yet complete, but is being rapidly enlarged. Concerning their duties, information may be obtained from the following

EXTRACTS FROM THE ACT OF THE STATE LEGISLATURE,

Entitled "An Act to define and enlarge the duties of the Board of State Viticultural Commissioners, and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture," approved March 4, 1881:

SEC. 3. The Viticultural Health Officer shall have power, subject to the approval of the Board, to prevent the spread of vine diseases and vine pests, by declaring and enforcing rules and regulations in the nature of quarantine, to govern the manner of, restrain, or prohibit the importation into the State, and the distribution and disposal within the State, of all vines, vine cuttings, debris of vineyards, empty fruit boxes, or other material, on, or by which the contagion of vine diseases and germs of vine pests may be introduced into the State, or transported from place to place within the State; to declare and enforce regulations approved by the Board for the disinfection of vines, vine cuttings, vineyard debris, empty fruit boxes, and other suspected material dangerous to vineyards, while in transit, or about to be distributed, or transported into, or within the State; to classify the vineyards and viticultural regions of the State, according to the degree of health, or vine disease prevailing therein, and to change the same as circumstances may require to be done, subjecting each class to such varying rules and regulations, respecting the introduction or transportation of vines, vine cuttings, and other material liable to spread contagion of disease among vines, as may, in the opinion of the Board, become necessary and expedient for the preservation of vineyards. Such rules and regulations shall be circulated in printed form by the Board among the vine growers and fruit dealers of the State, shall be published at least thirty days in two daily newspapers of general circulation in the State, not of the same city or county, and shall be posted in a conspicuous place at the county seat of each county affected by their provisions.

SEC. 4. The Viticultural Health Officer may appoint local resident Inspectors in any and all of the viticultural regions of the State, whose duties shall be to report to him concerning the health of grapevines, the progress of vine diseases and pests, and all violations of the rules and regulations of the Board; to certify to the proper disinfection of vines, vine cuttings, empty fruit boxes, and other transportable articles required by the Board to be disinfected before transportation, or while in transit, or after delivery at any point of destination; the methods of disinfection to be determined and approved by the Health Officer and the Board; to seize upon and destroy all vines, vine cuttings, debris of vineyards, empty fruit boxes, and other material liable to spread contagion, which may be found in transit, or delivered after transportation, not certified to as required by the Board; *provided*, that the same may be exempt from such destruction if the cost of disinfection by such Inspector shall be provided for by the owner or agent in charge thereof, as may be prescribed for such cases of negligence, carelessness, or violation of quarantine rules, and to keep a record of all proceedings as such Inspectors; *provided*, that there shall be no compensation for such services of inspection, excepting a fee, not to exceed one dollar for each certificate of disinfection, in case of compliance with quarantine regulations, and not to exceed five dollars for each certificate of disinfection after seizure for non-compliance; *provided, however*, such inspector may be employed at the option of the owners of property requiring disinfection to disinfect the same. All vines, or other articles absolutely prohibited of importation or transportation, may be promptly destroyed by any Inspector discovering the same transported or in transit, in violation of regulations, and the cost of such seizure, together with a fee of ten dollars, shall be paid to such Inspector out of any fine that may be collected from the party or parties guilty of such violation. Willful violation of the quarantine regulations of the Board shall be considered a misdemeanor, and punishable by a fine of not less than twenty-five not more than one hundred dollars. Whenever required for the convenience of vine or fruit growers, or fruit dealers, a resident Inspector shall be appointed upon petition of any three neighboring vine or fruit growers, or dealers in grapes, to reside in their vicinity, if not already provided for; and there shall be not less than two Inspectors appointed for each county which is subjected to such quarantine regulations, and they shall each be subject to removal at the will of the Viticultural Health Officer, if incompetent, or if they fail to perform their duties, or are unreasonably distasteful to vine growers and grape dealers.

Printed copies of the quarantine rules, for posting in conspicuous places, have been sent to the Sheriff of each county of the State, and to all Postmasters. Our request to have them posted has been complied with in all cases that we have heard from.

The same has been printed in pamphlet form and, together with the report of your committee on phylloxera, have been circulated throughout the State.

It is not pretended by this office that an absolutely perfect quarantine can be enforced. We expect, however, to realize great benefits through awakening public interest in protective measures and the moral effect of united efforts, aided by the information that will be circulated in all districts by an active corps of Inspectors. Unless the people cordially support the efforts of this corps, we cannot realize the great good we look for. We therefore appeal to the people for friendly assistance, counsel, and information. This Commission affords the means for effecting grand coöperation, the fruits of which will be more satisfactory work in the future. We desire to act arbitrarily as little as possible, and to avoid the necessity for appealing hereafter to the State for greater powers. The labor that this quarantine imposes upon this office is almost more than can be endured; the correspondence that grows out of it is consuming the greater part of our time and strength. We shall feel, therefore, deeply indebted to the Inspectors in their several localities for all that they can do to relieve us, assuring them that such information as we possess and can send to them will be furnished as promptly as practicable. Friendly suggestions and advice will always be not only thankfully received, but sincerely solicited; and our correspondents are requested not to be too easily offended by any apparent neglect in acknowledging their services, and replying to their questions. The field of our labors covers a great State, and we are physically unable to perform more than a small part of them in one season.

FOREIGN CORRESPONDENCE.

The foreign correspondence of this office has become very interesting and much enlarged. We have attempted to do justice to this branch of our work, but without assistance this is impossible, for want of ample time. Fortunately we have now obtained the promise of aid in this respect, through the kindness of Mr. Frederick Pohndorff, who will act as Assistant Secretary for foreign correspondence. Our resources for information will thereby be greatly increased.

NOTES FROM CORRESPONDENTS, ETC.

Professor G. Foëx writes from Montpellier, France, that the seedlings of the *V. Californica* and *V. Arizonica*, at the National School of Agriculture, are progressing well, and that he hopes during this Winter the roots (some being two years old) will be characterized sufficiently to study.

The seeds sent to Australia, we are informed by Mr. Creighton, of the *Evening Post*, have produced fine plants, and are attracting much attention.

Those sent to the Phylloxera Commission of the Douro, Portugal, were widely spread throughout the country, and in respect to vigor of growth compared favorably with the *Riparia*, which has been the favorite species. The *Californica* seedlings, during the first year, appear to be troubled, in many places, with the *peronospora viticola*, or white mildew, so much so in Portugal, that the Commission there was alarmed lest a focus of disease might be established. It seems that such alarm must have been unfounded, because the germs of the disease were those of the country, and not imported; moreover, the same experience here and at Montpellier was met with, the troublesome fungus not being serious, if at all to be found, when the plants are older. Seedlings, also, have been affected in such places, either watered or in moist soil, where this form of mildew is quickly produced and attacks certain species and varieties. If the *Californica* is subject in foliage to these attacks, it is scarcely probable that it will be affected when grafted, any more than other grafted stocks. The *Riparia* is free from this mildew, while the *Æstivalis* is affected by it. Sulphur appears to have no effect upon it.

Dr. Adolph Blankenhorn, of the *Œnolagisches Institut Karlsruhe-Blankenhornsberg*, Mullheim, Karlsruhe, has forwarded many of his valuable publications, and has written for information on certain points. One question relates to the difficulty of procuring seeds from vines completely ripe. He desires to know how vines should be treated so as to obtain ripe seeds. My experience in raising seedlings, indicates that the seeds of wild vines, gathered from vines in wild state, germinate as readily as can be desired. I have sowed *Californicas*, *Arizonicas*, and *Riparias* in ordinary drills with a seed-sower, with the same success that may be obtained by ordinary field work; at the same time seeds of American and European cultivated varieties were practically failures, very few germinating. I would respectfully suggest that good seeds of cultivated vines might possibly be obtained by permitting the vines to run as in the wild state. The fruit would be small and the seeds probably better matured.

Another question from Dr. Blankenhorn: he writes that he has read in the report of some English Consul, concerning viticulture in California, that the phylloxera cannot increase rapidly here, because its natural enemy, the *tyroglyphus*, kills and devours a great quantity of them; and desires further information on the subject. We are unfortunately unable to give at present what is desired, but, as in many other cases, we shall draw upon him for the following statement of the progress made in solving one branch of our common work, trusting that at some time, in future, California may have more to offer in exchange for what she receives:

[Translation.]

TO ALL WHO STUDY THE PHYLLOXERA QUESTION.

As it has hitherto been quite impossible to get information about the phylloxera and its peculiarities, I have determined, as has often been stated in these annals, to establish on a large scale the sale of preparations of this insect. The German Imperial Government has assisted me by defraying the expense of preparing a considerable number of phylloxera collections.

The great labor, both scientific and commercial, which this commission has involved, has thoroughly taught me the difficulties which beset such an undertaking, and but for the assistance of many friends which my extensive connections secured for me in my work, we should not even now be in a position to study the phylloxera with the help of complete collections. In spite of the most unremitting exertions, I have been unable to procure a sufficient number of male and female winged phylloxera, or of Winter eggs.

There are two distinct branches of the subject to be studied:

First—The history of the development of the phylloxera itself;

Second—The organization of the means for combating it.

The former has been taken up heartily by specialists in all countries; the second has been almost everywhere more or less neglected. It has happened in this case, as with most acquisitions made by scientific research: only a very few learned and devoted men have profited by them—and, consequently, in spite of the sad experience in France, Klosterneuburg, etc., most of the centers of phylloxera infection, had assumed alarming proportions before they were discovered.

But how is it possible to provide for the discovery of centers of phylloxera at their very commencement? After what has been said, this question will be asked by all impartial persons. The answer is extremely simple, and shows that we agriculturists are taking the wrong course, inasmuch as we look to the State for everything and choose to support it only by material and not by intellectual contributions.

If the more intelligent among us do their duty, and make themselves conversant with the peculiarities of the phylloxera, either by going through a course of instruction, or by providing themselves with complete phylloxera collections, they will be enabled, on the first appearance of any remarkable symptoms of disease in the vineyards of their districts, to decide whether the disease is due to the phylloxera, or to any other cause. Should it thus appear that infection by phylloxera has begun, the uprooting and burning of the diseased vines, together with disinfection of the soil, will suffice to stop the further spread of the disease. But if the infection has gone further, it will be no longer possible, or, at least, only feasible at very great expense, to get the better of it, as has been shown by the sad examples in Klosterneuburg and France.

The best way to train the necessary experts would be by courses of instruction in which the gentlemen who attend them, by working for seven or eight hours a day at the microscope, and by attending about six lectures and demonstrations, would be able, in about a week, to acquire the necessary familiarity with the method of searching for phylloxera, and similar microscopic insects which also live on vines.

Such courses have been established in Germany and Austria only, and in both countries have been discontinued after a comparatively short time, for want of attendance. So nothing remained but the plan (which was not to be rejected, though it promised less result) of training Phylloxera experts, by spreading far and wide a number of preparations, and especially specimens of nodosities, infected roots, and leaf-galls preserved in spirit.

The almost insuperable difficulties which I experienced in making collections sufficient for demonstrations in the courses delivered in my institute, convinced me that it was the duty of my institute to provide that other scientific and practical men should not meet with the same obstacles, and I resolved to issue the collections hereafter specified.

In offering them to the public, I need scarcely add that my undertaking is intended to serve the general interest rather than my own, while at the same time, by carrying it out, I hope to obtain the means for highly interesting investigations, both scientific and practical, on the phylloxera, which, even at the outset, are very promising. May my collections conduce to the discovery of many a small center of phylloxera infection, and thereby ward off untold injury from many a district. By the fulfillment of this hope I shall be amply rewarded for the many disagreeable hours which I have spent in revising microscopic preparations, and still more in the tedious and far from intellectual drudgery connected with my undertaking.

The collection will consist of two divisions. The first embraces the different forms of the phylloxera itself (with the exception of specimens of the distinct sexes and Winter eggs); the second, of other microscopic insects which live on vines.

DIVISION I.—PHYLLOXERA.

A. Form which Lives on the Root.

Number.	*a.* Microscopic Preparations.	s. d.	Each. s. d.
1–2.	Eggs of sexless phylloxera	2 0	1 0
3.	Egg-shells of sexless phylloxera	1 0	1 0
4–6.	Young phylloxera, sexless form	3 0	1 0
7–9.	Middle-aged phylloxera	3 0	1 0
10–12.	Full-grown phylloxera	3 0	1 0
13–14.	Full-grown phylloxera, containing egg	4 0	2 0
15–16.	Full-grown phylloxera, Winter form	2 0	1 0
17–18.	Phylloxera casting their skins	4 0	2 0
19–20.	Skins of sexless phylloxera	2 0	1 0
21–22.	Nymphs	8 0	4 0
23–24.	Winged phylloxera	8 0	4 0

Number.	*b.* Preparation in Spirit.	Each. s. d.
I.	Strongly infected roots with phylloxera, to demonstrate the method of examining infected roots	3 0
II.	European roots very slightly infected	3 0
III.	American roots with nodosities	3 0
IV.	European roots with slightly preserved nodosities	3 0

Roots of American and European vines are indispensable for the comparative study of the influence of the phylloxera on vigorous and weakly vines. The nodosities of the American vine do not rot so soon as those of the European vines, which very frequently are perfectly rotten as early as in the month of September.

B. Form which Lives on the Leaf.

Number.	*a.* Microscopic Preparations.	s. d.	s. d.
25–26.	Eggs of sexless gall phylloxera	4 0	2 0
27–28.	Young insects from galls	4 0	2 0
29–30.	Adult insects from galls	4 0	2 0

Number.	*b.* Preparations in Spirit.	s. d.
V.	Leaf from an American vine, with galls, planted in Europe	5 0
VI.	Leaf from an American vine, with galls, planted in America	5 0

The habits of the phylloxera on American vines planted in America, and on the same vines planted in Europe, seem to differ materially.

DIVISION II.—OTHER MICROSCOPIC INSECTS LIVING ON THE VINE.

This division of the collection which I am about to issue, will be hardly considered less important than the first; for other insects living on the vine have too often been mistaken for the phylloxera.

I believe that nature provides us with two means of conquering the phylloxera:

1. By encouraging diseases to which it is subject.
2. By planting vines which do not succumb to it.

The history of all epidemics shows that they are merely conquered by a careful investigation and use of the means which nature has placed at our command. By studying the small centers of infection in Germany, we come to the conclusion that such means exist; for otherwise it is impossible to explain the presence of phylloxera for ten years in such extremely small quantities. We are, therefore, bound to study them most assiduously, as well as the natural enemies of the phylloxera. For many years I have observed the insects which live on the vine, and thus had been led to suppose that for the most part they exist in small numbers, and are not to be taken notice of in the phylloxera question. But I have taken a different view after some recent research at Vevey Blankenhornsberg, and Mascoutah; and I have found that many insects live in such numbers on the vine, as to be able to overpower the phylloxera in the early stage of the infection.

In the Summer of 1876, I have been confirmed in my opinion on this subject by experiments I have made with living phylloxera. I have often mentioned in the "Annals" that in several breeding apparatus the phylloxera completely disappeared in presence of a large number of tyroglyphus phylloxera. Similar observations have been made by Mr. Schrader and Mr. Oberlin (by the latter in the open air). In my experiments of the above-mentioned Summer, at first a great number of phylloxera, and only a few specimens of tyroglyphus phylloxera were discovered on infected roots; but in September the phylloxera had entirely disappeared, and tyroglyphus showed itself in large numbers. In another breeding apparatus I had a root strongly infected with phylloxera, on which I placed ten living specimens of polyxenus lagurus; in the course of a fortnight the phylloxera were more than decimated, and all the polyxeni were alive.

Number.	Microscopic Preparations.	s.	d.	s.	d.
1–2.	*Coccus vitis*	3	0	1	6
3.	*Hoplophora arctata* (Riley), enemy of phylloxera[1]	4	0	2	0
4.	*Hoplophora arctata,* with egg	2	0	1	0
5–6.	*Hoplophora arctata* (Schild)	2	0	1	0
7–8.	*Tyroglyphus phylloxerae* (Riley), enemy of phylloxera[2]	4	0	2	0
9–10.	*Polyxenus lagurus* (de Geer), to be considered an enemy of phylloxera	2	1	1	0
11–12.	*Gamasus spec?*	3	0	1	6
13–14.	*Nothrus mutilus*	2	0	1	0
15–16.	*Nothrus scaliger*	4	0	2	0
17–18.	*Larva spec?*	2	0	1	0
19–20.	*Bdella spec?*	4	0	2	0
21–22.	*Heliothrips spec?*	4	0	2	0

The price of the two collections will thus be about £5—about as much as will cover their cost of production.

My preparations can be procured: At Sickler's (instrument maker to the court), Carlsruhe; for Austria and Hungary, at Dr. Egers', Naturalien-Comptoir, Vienna; at Franz Batka's, Prague; for Italy, at the Agenzia enologica italiana, Milan. The preparations may be bought singly.

DR. AD. BLANKENHORN,
Professor of Viticulture; President of the German Society of Viticulture;
Director of the Œnological Institute, at Karlsruhe, etc.

The Secretary of our Commission, Mr. J. H. Wheeler, has already made a number of preparations of the phylloxera in its varied forms, also of infected roots. The leaf gall has not yet been discovered in our State, though we are unprepared to say that it does not exist. This labor, comprehending not only the phylloxera and its enemies, theory, that the European varieties of the vine may be made resistant to the phylloxera by some recuperation or regeneration of its vitality, is still entertained by leading thinkers, such as Dr. Blankenhorn and others; and we may feel encouraged in further experiment.

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[1] See Annalen der Œnologie, vol. VII., p. 44.

[2] See Annalen der Œnologie vol. VII., p. 43.

Of the seeds of the vine of *Soudan*, received last Winter from Bordeaux, only one germinated. The plant grew throughout the Summer in a pot, but showed signs of great delicacy, and was evidently sensitive to a cool atmosphere. It does not appear to be suited to our climate.

The seeds of the wild vine of *Kashmir* germinated well, and grew with sufficient vigor. These were procured by J. H. Drummond, Esq., of Glen Ellen, Sonoma County.

The Report of the Phylloxera Commission of Portugal contains an interesting description and illustrations of the Government manufactory for the bisulphide of carbon, and information concerning the distribution of this insecticide among the vine growers of the Douro; also concerning experiments with seedlings of the American vines, among which are the *V. Californica* and *V. Arizonica.*

PERSONAL INSPECTION OF VINE GROWING DISTRICTS.

I have visited during the vintage season, this year, the leading vineyards of the Sonoma, Napa, St. Helena, Alameda, Santa Clara, Santa Cruz, San Joaquin, and El Dorado districts. The varieties of vines cultivated, and methods of culture and pruning have been the special subject of study; but my observations are yet so incomplete that I shall not enlarge upon them. A few points and questions should however be referred to.

Great confusion exists in the nomenclature of vines. To explain this would require much more time and space than can be afforded here. One important reason for it is to be found in the fact that many vineyards are now in possession of persons who acquired them by purchase after they had been planted. Originally they were set out with many varieties, each in small quantity, as the cuttings could be procured; the names have been lost, and thereby the opportunity of obtaining wood for propagation true to name of variety. Carelessness in original nurseries has also had serious effects. In some cases, no doubt, cuttings came to our State mixed. We find the *Folle Blanche* and *Colombar*, varieties grown in the same (Cognac) vineyards, have been in many cases confounded. The *Mataro* has been confounded with the *Meunier*, or *Miller's Burgundy;* the *Malvasier* with the *Pinot.* There is confusion between the *Colombar* and *Sauvignon*; but this is not so important, because these vines are naturally associated, and are of equal relative value. The *Cabernets* and *Malbecs* are mixed. The distinctions in the raisin *Muscats* are not well preserved. The so-called *Black St. Peters*, in most cases, is the *Zinfandel.* The distinctions in the varieties of *Pinots* are lost under doubtful names. The so-called *Gray Riesling*, or *Gray d'Ischia*, is, undoubtedly the *Chauché Gris.* The *Chauché Noir* is often called simply *Black Pinot*, thereby confounding it in name with the leading true *Burgundy* variety. The *Chauché Noir* and *Gris* are called, in some parts of France, *Pinot de Poitou*, but they are different from the Burgundy *Pinots*, which have trailing canes. The true *Meunier* or *Miller's Burgundy* is, in some places, confounded with the *Madeleine.* The *Gamays* are generally entirely lost to recognition. The *Rieslings* are too arrogant; they affect to be too numerous altogether in variety. The *Sauvignon* passes under the false names of *Folle Blanche, White Burgundy,* and *White Green Reisling.* The true white *Burger,* or *Weiss Elbling,* is found under one of its proper synonyms, the *Kleinberger,* of which the *Blaue Elba,* or *Elbling,* is a variety. The so-called *Burger* is evidently misnamed; it resembles the *Folle Blanche* in leaf, wood, compactness of berries, fertility, and general appearance; also in the lightness of its wine, but not in quality. It undoubtedly came from the Rhine, but it does not answer to any description of any standard Rhenish variety. The books are evidently at fault in failing to describe such a notable vine. The words *Gutedel* and *Chasselas* should be synonymous; the former German, the latter French, for a family of varieties, such as the *Roth Gutedel* or *Chasselas Rose,* etc. The *Golden Chasselas,* so-called, at St. Helena and in some other places, is probably misnamed; it is apparently not a *Chasselas.*

The *Malvasier,* or *Black Malvoisie,* has nothing in common with the family of *Malvoisies* of the south of France and Spain. It came to Santa Clara County under the name of *Malvoisie noir de Berlin.* Stoltz, in his *Ampelographie Rhénane,* gives the name *Malvasier* as one applied to a variety of the *Trollinger,* or *Black Hamburg,* in one part of Germany. The *Sylvaner,* or *Franken Riesling,* is called *Green Hungarian* in El Dorado County. The "Johannisberg" *Riesling* is simply the true *Riesling,* or *Gentil-aromatique,* of the Rhine. There is no reason for calling it "Johannisberg"—it might as well be called Schramsberg, or Crabb's, or Krug's. The *Chasselas Rose* is generally a misnomer; under it is found the *Barbaroux,* or *Grec Rouge.* The *Verdelho* in one place is found under the name *White Madeira.* The *Charbono* is sometimes miscalled *Burgundy.*

Many noble and fine varieties, such as the *Cabernet, Merlot, Melon blanc, Verdelho, Petit Pinot, Folle noir,* etc., have been neglected, although to be had in good numbers. So also with such prolific and profitable varieties as the *Folle Blanche,* which is now being sought after for brandy vineyards. The *Sauvignon* is coming into deserved favor.

The importance of correct nomenclature is not well enough recognized. Through the correct name, or any authenticated synonym, we may trace the history of the vine and its adaptations in other countries. This we should do before planting. The early ripening varieties, such as the *Riesling* of the Rhine, and the *Pinot* of Burgundy, are not productive of fine wines in southern climates, unless planted in cool tardy exposures. The late ripening varieties of Spain and the south of France do not succeed in northern districts. The late ripening varieties of the North are frequently improved by moving south. Our climate, resembling that of the Mediterranean Coast, Spain, Portugal, and Italy, is generally better adapted to southern than to northern varieties. The *Mission,* of Spanish origin, succeeds more or less well in all our leading districts; so, also, so far as tried, do the *Grenache, Mataro,* and *Carignane.* The *Northern Rieslings, Pinots,* and *Zinfandel* are more difficult to suit and produce fine wines only in a few sections. The *Riesling* here, as in Europe, loses its character in southern climates, except in certain northern exposures. Generally speaking, a northern exposure should be selected in California for the early ripening wine grapes.

In culture, we have all the governing principles to learn. In planting, before determining the distances apart for the vines, we should know by what method we intend to prune. It should be remembered that, other things being equal, the cubic space occupied by the roots should be in proportion to the development of the plant above. The converse of this proposition furnishes one guide to pruning, viz.: the development permitted above should be proportionate to that below ground. It is as bad to give vines much root space and then to prune the head too small, as it is to plant too close, and to leave too much wood for vegetation. Want of attention to these principles causes such diseases as black-knot, and waste of sap in useless suckers, and unnecessary length of new canes, on the one hand, and exhaustion of vitality through overbearing, on the other. A vine should be so pruned that all its strength is utilized in three directions, viz.: first, in producing strong healthy canes for next year's fruit; second, in nourishing the fruit canes of the current year; third, in a certain limited development of suckers, or dormant eyes, to create new fruit arms, or branches. I know many vineyards where the strength of the vine is wasted in making useless wood for bonfires, all of which might have been utilized by more generous pruning. When pruned so close and so restrained, the vines had better be planted closer in the field.

The black-knot has caused much complaint this year. Specimens with inquiries have been sent to us from all parts of the State. Many have supposed it to be some form of disease, to be dreaded as contagious. To comprehend its nature and to suggest remedies, we must first study the flow of sap during the early vegetation of the vine in Spring. This will lead us also to the principles which should govern pruning.

Dr. Jules Guyot, the most eminent of French authorities, teaches us that under the influence of heat and light the vital movement commences in the Spring time, in advance of vegetation of the vine, and speedily there is a motion of the sap upwards, defying the law of gravitation, which forces open the buds and pushes new shoots into existence, which are fed temporarily by the sap accumulated during the preceding year in the old wood, and the water that is absorbed from the soil. Subsequently it is the leaf which draws the water from the soil and absorbs the carbon for the descending flow, while exhaling oxygen. The force of the upward flow of water and sap has been measured and found capable of sustaining a column of mercury of from thirty-two to forty inches—equivalent to a column of water of from about thirty-two to forty-five feet in height. This force must even be greater than found by experiment, because the ascending force has been known to start vegetation in branches of the vine sixty to one hundred feet in height, and in gigantic trees of three hundred and more feet.

It is apparent, therefore, that serious consequences may happen to the tissues of the plant if this ascending force, which concentrates the nutritious accumulated sap in the direction of new growth, is not followed promptly by a corresponding new development. It happens that sometimes:

First—The vines have been pruned so that the buds for new growth are not proportionate to the root development, or the vigor of the plant, which may vary constitutionally, or through conditions of soil, culture, and climate. The consequence is a surcharge of the canals, swelling of tissues, exudations of sap, and disorganizations, which become seats of local disease and decay. Black-knot is the consequence.

Second—The buds of the wood intended for the further development have been injured by frost, or other cause, accomplishing like results, as in the preceding case.

Third—The growing and green shoots are seriously injured by fungoid disease, the tender bark destroyed, the healthful flow of sap impeded with similar consequences upon the new wood of the current year.

We find that black-knot affects certain varieties of vines more than others, such as the *Rose of Peru* and *Muscat of Alexandria*, and that these are also the varieties, which furnish immatured wood so disappointing to those who plant cuttings. We find that this complaint of the vine is more frequent in situations of rank soils, wet, or fat lands, where the new wood does not ripen well before severe cold strikes them, and in places subjected to early and late frosts. I have not known a case of an arbor vine affected by black-knot, though it may be looked for where the same has been severely injured by mildew, which may cause its wood to fail to mature. A vine raised high, however, offers so many opportunities for the development of suckers that dangerous results may not follow, as where low pruning is practiced. The remedies are therefore to cultivate hardy varieties in situations where black-knot is common, to raise higher the varieties subject to the trouble, both to escape frost and to permit more opportunity for vegetation, and especially to prune generously, to the extent that the natural vigor of the plant will endure it. Planting vines far apart, in rich deep soils, in warm climates, with excessive irrigation, combined with the low and close pruning, will always be attended with more or less black-knot, according to the variety cultivated. There is now a tendency to give vines more room in making new plantations; if this be not followed by generous pruning, and the plant be not given sufficient expansion, the expected advantages will not only not be realized, but positive evils will result. With such ordinary pruning the vines would succeed better if planted closer.

There are many objections to raising vines high, or upon trellises, notwithstanding the increase of vigor, fertility, and longevity thereby obtained. The fruit is the primary object of viticulture, and for the sake of quality nature must be restrained. Fine wines, fine color, are results of low pruning. Low pruning and upright plants with great expansion are impractical in field culture generally. Hence it becomes necessary to study a happy medium, so that the space occupied may be only sufficient to maintain a plant of the desired expansion. When that space becomes exhausted, fertilizing may continue fertility. Eventually the plant will decline, when it should be taken out, the soil rested and fertilized, and in future replanted.

It is, of course, unnecessary to say that practical convenience in working vineyards enters also into this question.

There are several systems of conducting vines so as to give them ample expansion, but all of them, excepting that called the *chaintre*, involves the necessity of costly establishments of stakes, wires, trellises, etc., and very scientific pruning, requiring expert labor. The culture of *chaintres*, I believe, is the rational and practical adaptation of nature in its full vigor to the purposes of the vineyard. I shall not at present attempt to describe it in detail, but will suggest only the principle. Vines are planted—as near Montrichard, in France—in rows about twenty-one feet apart, spaced in the rows seven feet apart. About three hundred, instead of three thousand, to the acre. These vines are then suffered to trail in one long stem with side branches over the ground, the entire distance between the rows. When required small props are placed under the branches to raise the fruit above the ground. This would be unnecessary for many varieties in this State. Several important advantages are secured: the vine is suffered to retain its full vigor and fertility; extraordinarily long pruning is possible; the fruit ripens evenly; quality and color are obtained; and pruning is a simple operation, reduced to a few easily taught principles. In the early stage of the vine's growth, it is so conducted that the main stem near the trunk is preserved flexible. In cultivation the vines are lifted and moved aside to permit the passage of the plow, and then returned to their places. Experience in France, in the district where this system was invented, and where it has been perfected, shows that the yield of vineyards has been more than doubled. It is, however, a very modern discovery, and is little known outside the region where it is practiced. I am quite certain that it is the best system for our raisin makers, who have found that trailing the canes of the *Muscats* on the ground produces the best results. I would suggest it also to those who have vineyards diseased with phylloxera, which they desire to reconstitute on phylloxera-resistant stocks, while they are yet receiving remunerative crops from the affected vines. Every third row of vines might be removed, the soil carefully prepared and fertilized, and replanted with resistant stocks. These may then be grafted and, until the main stem has sufficiently developed to lay down, be fastened to a stake. When ready to be established as a *chaintre*, the rest of the original vineyard may be uprooted and in its place will be established the new system. Meanwhile the old vines have been producing revenue. It is difficult generally to propagate successfully between old vines a row of young plants; but by planting only strong-rooted American stock, the vigor of which surpasses the European varieties, and by equally fertilizing between the two rows of old vines, to prevent them from seeking to rob the young plants, I believe this attempt would succeed. It is certainly worthy of experiment.

In methods of planting and propagating vines, success has attended many new efforts in this State. At Glen Ellen, in Sonoma County, single eyes have been propagated, producing fruit the second year. The advantage of deep plowing, subsoiling, and planting cuttings with the spade instead of the dibble, dipping them first in a prepared compost and packing fertilized, or surface soil about them, has been well proved during this year. Many new tools for digging holes are being invented, some with positive merit. Better care is now taken of cuttings between the time they are made and the time planted. Stratifying, or packing them with sand and mounding over with earth, is being practiced by some.

The most important plantation of American vines that has been attempted thus far, is that of Mr. Jas. W. Simonton, in Napa County. Several hundred acres are planted, and being planted, in resistant stocks, both for direct production and future grafting. Among the stocks put in this winter are twenty-five thousand seedling *Riparias*, and thirty thousand seedling *Californicas*. The State will watch the progress of this vineyard with great interest. Being under the management of Professor George Husmann, recently of the University of Missouri, we have in effect in this a well organized experimental vineyard for testing resistant stocks, amply supported by private means, and ably conducted for the demonstration of one branch of viticulture.

There is great difficulty experienced in propagating by cuttings the *Æstivalis*, and some other varieties of American resistant stocks. Much loss will be saved by cutting the canes short—say to eight or ten inches long, and starting them in hot-beds, protected from frost before the time of planting in the field. Then late in Spring plant in the field carefully, covering the top with light soil to protect the developed shoots from late frosts and from drying while the young roots are taking firm hold upon the soil, which has first been suitably fertilized. Dipping the base of the cuttings as they are taken from the hot-bed in a rich wet compost, suitably prepared, before taking them to the field, and not removing them from it until at the point of planting, will also have much advantage. This can be done by carrying them to the field in tubs, or buckets, partially filled with the compost. I see no reason why the same may not be done with advantage when planting the more easily rooting European varieties. A short cutting so planted that the top is covered with light, fine earth, and that the base is not too deep, but within the influence of the warmth of the sun, will make a finer development than when long cuttings are put so deep that the roots at the base develop poorly, and the part projecting into the air is subjected to drought and cold. Many plant their cuttings too deep, poor roots being the general result, and oftentimes failure resulting from the unequal conflict between the bursting buds, which dry up in the air before the roots can nourish them. No precise rule however as to the depth of planting can be made on account of the different characteristics of soils. Experience and the exercise of sound judgment only can determine what shall be the depth of planting. The long cutting, the base of which is bent horizontally in the bottom of a hole, twelve to fourteen inches deep, succeeds well in light, dry soils; but I have noticed failures in moist adobe and cold lands. Cuttings planted too deeply produce plants of slow fruitage.

In grafting old vines, as will happen often in cases where the black-knot has seriously injured them, the best success is obtained by covering the amputated trunk and exposed tissues with fine clay. Clay is also best for sealing small grafts, but it should not be put on in too great quantity on young plants, for fear of strangling them when it bakes hard, and being too large a mass; refuses to break with the expansion of the stem.

During the past season, in many places serious effects were caused by mildew, some of the worst cases being in the foothills of the Sierra Nevada. This was probably caused by the unusual warm rains of the first part of June. In future, viticulturists should remember in time the dangers of such rains, and sulphur their vines soon after the rain has dried off the foliage.

LECTURES AND ADDRESSES.

During the past year I have also had the honor to address, by invitation, the El Dorado Agricultural Society at Placerville, the San Joaquin Grange, at Lodi, the Sacramento Viticultural District Meeting, at Sacramento, the Santa Clara Viticultural Association, at San José, and the Association recently formed at Pleasanton. Invitations to deliver other addresses on viticultural topics have been received, but I have not been able to accept them. I shall take the liberty to reproduce here, an extract from my address at Placerville, inasmuch as it bears directly upon the urgent wants of our industry, and, as I believe, should receive more public attention. I extract as follows:

Among the immediate wants of the State are:

First—A standard collection, continually increasing in completeness and usefulness, of vines, trees, and plants, in connection with which should be a fully equipped experimental laboratory.

Second—An amply supported and well filled department of entomology and botany for the investigation of questions concerning insect pests, fungoid disease, the habits and aptitudes of plants, etc.

Third—Liberal State or United States aid in fighting the battles of industry against foes. If our industries are not worth preserving, then our government and its office holders are not, and we may abolish the army and navy. There are millions of dollars worth of vineyards and orchards—the pride and hope of the State—imperiled by invading armies of insects. Individual defenses are almost as vain as the pigmy armaments of a frontier settler against the attack of Apaches. Individual experimenting is too costly and too tardy to be relied upon. Congress can afford to lend its aid, because the general government has a direct interest in our success. Already the revenues of the United States are, from our pure brandies, more than half a million dollars per annum. These will increase until in ten years they will be more than a million of dollars, and if the tax is maintained, in fifty years our brandies will pay off the national debt. Congress can afford to remit ten per cent. of the brandy tax for the use of a special Commission in combating vine diseases.

Fourth—We need translated and compiled into our language all the valuable works of the French, German, Portuguese, Spanish, Italian, and Hungarian authorities on viticulture. The State Commission has commenced this work, but the resources of the State Printer are not ample for the whole field. Some will say, let the vine growers print, or buy their own books. The vine growers are the people; most of them inexperienced and do not know what they need. The State can afford to do the work, and take upon itself the risk of the publishers. If the next Legislature will undertake the work thoroughly, and not in a parsimonious spirit, it may provide easily for reimbursement through the sales of books and pamphlets. It may not be repaid in a single year, but before long its works will become a source of revenue.

Fifth—We want, in the interest of the whole people, to protect our industries from debasing competition of so-called cheap labor, whether it comes in the form of a Chinaman to our shores, or of a factory in China, France, or England. The spirit of all our laws should breathe pure Americanisms; for while we open our gates to the world, it is only that immigrants here may find themselves freed from degrading competitions to which they have been subjected elsewhere. The Chinaman who brings his debasing influence here—whose only ambition is to be used as a tool to strike down the comforts of our own working people, and to subject them to the parsimony of avarice, is not what we want. Neither do we want such labor as his to crush our industrious classes, whether it is here with us, or imported. My friends: If you value the peace and prosperity of your country; if you desire to see labor honored in the land, and compensated with a fair share of its own products, never listen to the delusions of those who would plunder us and enslave us under their sophistical "Free Trade;" never consider that a nation's wealth is measured by its exports. Get the statistics of domestic commerce, not of foreign commerce, if you wish to find material for self-glorification. Do not let the trader and the transportation companies—the middle men—wheedle you out of the fruits of home industry.

Sixth—We want diversified industry; not diversified in wholesale, but in detail, throughout the land. Every village should be as nearly self-sustaining as is practicable. Village life will then be a life of luxury, and transportation and brokerage will not devour your products, leaving you the husks. With the vine, we want, whenever practicable, the olive and the mulberry; and this leads us to another want, as well as providing for it.

Seventh—We want communities of settled workers, with their families and homes. This cannot be accomplished unless we have diversified industry. Every man who plants olives and mulberries, when he plants vines, will be insuring his occupation in the future against exorbitant wages and tramps. The mulbery will give work with the silkworms during the summer; the vine to the grape pickers and wine makers in the fall, and the olive to the olive pickers and oil presses in the winter. So can a community be kept occupied throughout the year. If we do not pay great heed to this question now, we shall need, ten years hence, a fresh importation of Chinamen to work our new and enlarged vineyards. I wish to impress this above all. See that there is continuous work, all the year through, in each community. See, also, that it is made easy for industrious families to settle upon and cultivate small, five and ten acre, homes in your settlements. This is your only salvation from Chinese and tramps. In your plantations do not consider only the temporary profits. We can induce the right kind of people to come among us as soon as we prepare the way for them to earn a living.

After all these important steps have been carefully taken, then we shall be on the high road to success, beyond the fear of reaction. Then may we say: this State can produce one thousand million gallons of wine per annum, clothes for all, food for all, independence for all. Now we cannot truly say this, for we have not the industrious and skilled hands to do it, and we are not prepared fully to invite them to come.

VITIS CALIFORNICA AND VITIS ARIZONICA.

On this subject, we shall at present not enlarge, further than to report that experiments with these wild vines of California and Arizona are most encouraging, and to recommend further efforts to determine their values as grafting stocks and direct producers. In Appendix C is given a plate illustrating the seeds of American species and varieties studied by Professor Millardet. For further study and comparison, we present illustrations (Fig. 7) of the seeds of *V. Californica* and *V. Arizonica*, enlarged on the same scale.

FIG. 7.

1. Dorsal and Ventral Views of the Seed of the *V. Californica.*
2. Same of the *V. Arizonica.*
Size increased twice the natural dimensions.

IN CONCLUSION,

We desire to acknowledge the valuable assistance which we have received during the past year, not only from viticulturists, and especially from the press of this State, but also from Professor E. W. Hilgard and others of the State University, the State Department at Washington, members of the foreign Consular service, and United States Consuls abroad. The encouragement which we receive on all sides is proof of the sure hold which viticultural industries have taken upon the hearts of the people.

It was intended to include in this report a treatise on varieties of vines grown in California, and upon certain ones which should be more extensively propagated in suitable places, also on pruning and on the propagation of cuttings and seedlings, but we deem it of more importance to publish, as speedily as possible, what we have already prepared rather than to suffer further delays, therefore this incomplete work is respectfully submitted to the Commission for immediate distribution, with the belief that it will be found to be of some value to our vine growers, as an aid in planting and culture, and as a guide for many new investigations and experiments.

CHARLES A. WETMORE,
Chief Executive Viticultural Officer.

APPENDIX A

TO THE REPORT OF

CHARLES A. WETMORE,

Chief Executive Viticultural Officer,

FOR THE YEAR 1881;

BEING A TRANSLATION OF THE PRACTICAL MANUAL OF VITICULTURE FOR
THE RECONSTITUTION OF SOUTHERN VINEYARDS IN FRANCE, BY
PROF. GUSTAVE FOËX, OF THE NATIONAL COLLEGE
OF AGRICULTURE AT MONTPELLIER, FRANCE.

PRACTICAL MANUAL

OF

Viticulture for the Reconstitution o Southern Vineyards.

American Vines—Submersion—Plantation in Sand.

BY GUSTAVE FOËX,

Professor at the National School of Agriculture, at Montpellier, France.

WITH THIRTY-TWO ILLUSTRATIONS.

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PREFACE.

Viticulturists find themselves, as to a choice of means for warding off the effects of phylloxera, in two very distinct situations: one, where the vines are still attacked or only threatened, the other where the vineyard is entirely lost. For the first, insecticides must be tried at once; they have a chance if the conditions of soil and climate are favorable and if their vineyards can support the cost of the treatment, of thus finding a means of saving important investments and of continuing, without interruption, the succession of their vintages. This work is not addressed to those who have the good fortune to be in the first situation; in fact, they will find, in the excellent publications of Messrs. Marion and Crolas, and of the old Viticultural Association of Libourne,[1] all that is necessary for them concerning the application of bisulphide of carbon, and, in those of Mr. Mouillefert,[1] information on the use of sulpho-carbonate of potash. We could, if desiring to treat these questions, only repeat that which has been well considered in these two books; they are, therefore, put aside in order to attend to the wants of viticulturists, too numerous, alas! who have lost their vineyards, with or without having used insecticides, or who cannot at all hope to preserve, by this means, those that they still have.

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[1] Chemins de fer de P. L. M.; *Instructions pour la Traitement des Vignes par le Sulfure de Carbone,* année 1878; Paris, imprimerie administrative Paul Dupont, 41 rue J. J. Rousseau. *Instructions relatives à la Disposition des trous d'Injection,* etc. (même édit). *Des Moyens Pratiques et sûrs de Combattre le Phylloxera;* Crolas et Falières, Paris; G. Masson, 1878.

It has indeed been proposed, it is true, to replant good soils with European varieties, and then to treat them with insecticides; but the irregular results hitherto obtained, and above all the necessity, as has been well said, of giving the vine a disease that must be doctored as long as the vine lives, causes the majority of practitioners, in countries that have already had long experience with phylloxera, to prefer reconstituting their vineyards on other bases, namely: Plantation in sand, submersion, and the use of American vines.

These divers means, whose efficacy is now no longer contested in the region where they have long been tried, are considered as regular cultivation; the number of vineyards thus treated is increased each year; therefore we deemed it expedient to collect together the information resulting from experiments made in this line by southern viticulturists, or those made by the author himself in the Agricultural School of Montpellier. This work, wherein there is not the remotest pretension to exhausting the various subjects that will be considered, was written with the endeavor of saving viticulturists the trouble of experimenting, through which their predecessors have passed. Facts that appear most surely established, and practices best justified up to the present time, are here grouped in a condensed and methodical form, under various natural headings, precedingly stated.

The order adopted in this work results from the following considerations: If the divers methods of reconstituting vineyards that are to be studied were to be classed with respect only to the facility of their execution, evidently plantation in sand, which is almost a pure and simple return to the old cultural methods, would be placed first; then submersion, which, without doubt, entails periodical expenses and special precautions, but which offers the advantage of permitting working directly on well known varieties, and without paying any attention to questions of adaptation and grafting.

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[1] *Le Phylloxera; Moyens Proposés pour le Combattre,* etc.; by P. Mouillefert, Paris; G. Masson, 1878.

Unfortunately, in general practice, one is seldom able to choose the order he shall adopt according to his own theories; circumstances nearly always impose the adoption of a determined system. Now, places wherein the first two means are realizable are necessarily very limited, so that the third, which may be applied everywhere, will necessarily be most widely adopted, and will, in consequence, play the most important rôle. Therefore, we place the *Study of American Vines* first, grouping around it all information relative to general viticulture, so that in the articles on Submersion and Plantation in Sand, only the special questions appertaining to them will need to be touched upon.

Such is, on the whole, the main idea in this work, wherein the author has had no other aim than to facilitate, in some measure, the efforts of viticulturists who have undertaken the great task of reconstituting the southern vineyards. Without concealing the insufficiency of his work, and all that might have been gained by waiting for more experience to come to light, he nevertheless believed that, under present circumstances, it was better for it to be incomplete than to wait.

MONTPELLIER, March, 1881.

PRACTICAL MANUAL OF VITICULTURE.

PART FIRST—AMERICAN VINES.

A. SELECTION OF VARIETIES.

CHAPTER I.

DESCRIPTION AND STUDY OF SPECIES AND VARIETIES.

The cultivated varieties in America are not derived, as those of the Old World, from a single type (the *Vitis Vinifera*); they spring from various botanical species, possessing very diverse characteristics, and showing distinct qualities in their varieties. Without attempting here a description of all the kinds now known, the majority of which afford only a purely botanical interest, we shall nevertheless study those that have produced varieties presenting some practical value, and we shall examine the most important.

1. Description of Species.

The species worthy of engaging the attention of the practical viticulturist are the following: 1. *V. Æstivalis;* 2. *V. Riparia;* 3. *V. Rupestris;* 4. *V. Labrusca.*

A. V. Æstivalis. The *V. Æstivalis* is characterized in the following manner: Plant of variable strength, generally medium. Canes climbing, large, and long. Tendrils discontinuous. Budding bright carmine red. Bursting of the bud and florescence nearly simultaneous with that of our European vines. Leaves sometimes entire, generally with lobes more or less marked, rather thick. The young leaves open flatwise at once; they are always covered on both sides with a tolerably thick down; the full grown leaves, almost downless on top, have underneath, on the large and small veins, hairs sometimes slightly rigid, sometimes flocculent, arranged in little tufts more or less dense or thinly scattered. Bunches with small berries nearly always prune-colored, without peculiar taste. Seeds medium, from two to three in number, rounded on the apex, with short and obtuse beak; chalaze circular, prominent; rhaphe prominent.

B. V. Riparia. The *V. Riparia* is a plant generally rather slender, attaining a large growth; very spreading. Canes climbing, long, generally slender, with lengthened internodes, sometimes glabrous, sometimes slightly villous (at the extremities only), with numerous branches. Tendrils discontinuous. Bursting of the buds and florescence very forward, consequently exposed to the Spring frosts. Leaves (young) plicated for quite a long while, sometimes slightly woolly; (full grown) heart-shaped, glabrous on both sides, or with a few bristly hairs thinly scattered on the veins only of the under side. Fruit, bunch generally small, of little berries with melting pulp; peculiar savor, less accentuated than in the *V. Labrusca.* Seeds with chalaze not prominent, lengthened, uniting with the rhaphe, which is soon lost in the median depression.

C. V. RUPESTRIS. The *V. Rupestris* is a plant of average vigor, spreading. Canes semi-erect, of medium length, with short internodes; branches rather numerous. Tendrils discontinuous. Leaves (young) as if varnished on the upper surface; (full grown) small, entire, heart-shaped or orbiculate, as broad as or broader than long, plicated, of a glaucous green, perfectly glabrous. Bunches small, with little berries of a bluish black, without peculiar taste. Seed small, somewhat resembling that of the *V. Riparia,* but with the chalaze and rhaphe less apparent.

D. V. LABRUSCA. The *V. Labrusca* is a plant usually of medium strength, yet sometimes shooting up very high. Canes large and long, climbing or erect. Tendrils continuous. Budding roseate. Leaves invested on the under side with a thick down, sometimes assuming a slightly metallic appearance. Bunch more or less large, with large berries round or ovate, with cartilaginous pulp and foxy taste; skin usually thick; maturity generally precocious. Seeds large; chalaze and rhaphe not apparent.

In order, however, to facilitate the determination of the species which we have just described, and to aid in distinguishing them, either our native vines or some other American types accidentally introduced in European culture, we have made out the annexed analytical key, which will be sufficient in the majority of cases:

Tendrils continuous			*V. Labrusca.*
Tendrils discontinuous.	Young leaves spreading out promptly.	First bud carmine red, not showing the bunches of flowers immediately. Down flocculent or rigid, in tufts on the lower surface of the full grown leaves.	*V. Æstivalis.*
		First bud roseate white, showing when it first opens numerous bunches of deep carmine flowers. Full grown leaves, with upper surface more or less convex, and covered with a cobwebbed down thinly scattered.	*V. Candicans.*
		None of the above characteristics	*V. Vinifera.*
	Young leaves remaining folded for some time.	Leaves as broad as or broader than long, and remaining folded an indefinite length of time.	*V. Rupestris.*
		Leaves as long as or longer than broad, and not remaining folded indefinitely.	*V. Riparia.*

NOTE.—Two varieties usually classed among the *V. Labrusca,* the *York Madeira,* and the *Diana,* have not the characteristic of continuance of tendrils, whereas the *Franklin, Clinton Vialla,* and *Elvira,* which are put among the *V. Riparia,* have this characteristic, but the hybridity of the majority of these types is now certainly recognized. (See Millardet; "Study on several wild species," etc.; Bordeaux, 1879, and G. Foëx; "Note relative to the origin of the *Elvira,* in the American Vine," June, 1879.

2. Description and Aptitudes of Varieties.

A. VARIETIES OF V. ÆSTIVALIS. The diverse varieties of *V. Æstivalis* may be considered as most especially qualified to be cultivated for the sake of their vintage, for which they are eminently fitted by the quality of their fruit, which has no peculiar taste, whilst the great price of their cuttings, and the relative difficulty in their propagation by cuttings, cause other varieties to be preferred to them as grafting-stocks.

The best known among them are the *Jacquez, Herbemont, Black July, Devereux* or *Lion* (Bush), *Cunningham, Norton's Virginia* or *Cynthiana, Hermann, Alvey, and Rulander* or *Louisiana.*

Only the first three or four appear qualified to have a settled place in European culture. The *Norton's* and *Hermann* produce too little, are difficult to propagate by cuttings, and thrive only in limited districts. The *Alvey* does not set well, and is grafted with difficulty, on account of the knotty nature of its wood. Finally, the *Rulander*, which is very likely a hybrid[1] of *Vinifera* and *V. Æstivalis,* is of doubtful resistance and not fruitful. We shall therefore confine ourselves to a detailed study of the four varieties mentioned first of this group, which alone, among those with which we are sufficiently acquainted at the present day, appear to be of some practical value.

Jacquez.—Although this variety may be designated in the United States by many different names, it is known in France only by that which we have just given, or sometimes by that of *Jacques*, which is not used in the South. Its principal characteristics are the following: Plant vigorous. Aspect semi-erect. Canes long, with internodes of average length, of medium size, nearly rectilinear. Leaves three or five-lobed, generally five-lobed; leaf-stalk indentation rather deep, almost closed; lower indentations very deep; two series of thin notches, generally waved; of a beautiful deep green and glabrous on the upper side; of a paler green and with tufts of silky hair on the veins of the lower surface. Bunch large, long, rather loose, tapering at the end, shouldered. Berry small, round. Juice a bluish black.

The resistance of the *Jacquez* to phylloxera is now proved by numerous and long repeated experiments. It is found to have been included in the first experiments made on American vines at Mr. Laliman's, at Bordeaux; Mr. Borty's, at Roquemaure (Gard); and Mr. Aguillon's, at Chibron (Var); and since then it cannot be said to have deceived us once in this respect.

Although it endures very well the ingraftment of most of our varieties of the Old World, for the reasons given above, it is for its fruit that it especially deserves to be cultivated. Without yielding so abundantly as our old European varieties of large produce, such as the *Aramon*, the *Terret*, etc., its production seems to approach that of southern varieties of medium fertility, which it surpasses by the qualities that its wine presents for blending.[2]

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[1] Histological study of the root had enabled us several years past to note the analogy of its tissues with those of *V. Vinifera.* Examination of the characteristics of the seeds, also, has since shown us great resemblance with those of that species, and many cultural experiments confirm the doubts that purely scientific information had aroused in us relative to the resistance of this variety.

[2] See Appendix, note two.

Not subject to chlorosis, the *Jacquez* has prospered in nearly all kinds of soil where it has been tried up to the present time; but it is in deep, rich, fresh, and very wholesome soil that it seems to yield the best results, as regards good development of its vegetation, and abundance of its produce.

The period of maturation of this variety is almost contemporaneous with that of the *Petite Syrah*. It is hardly able, however, to cross the northern limits of habitation of this last, on account of the ravages of anthracnose. They have had to relinquish it for this reason in the northern part of the Drôme, and in the United States it is found only in Natchez, in the Mississippi Valley, and in Texas; while Ohio and Missouri, which had formerly attempted its cultivation, have given it up. It may, then, be regarded as an essentially southern variety.

Finally, if we consider it with respect to multiplication, we shall notice that if it does take root by cuttings with a little more difficulty than the divers varieties of the groups *Riparia*, *Labrusca*, and *Vinifera*, it may nevertheless be propagated advantageously in this way. Upon condition of using healthy and well preserved cuttings, and employing some precautions easily learned, it is not unusual to see it thrive in an irrigated nursery in the proportion of eighty or ninety per cent. On the whole, the *Jacquez* may be regarded as the best of American vines cultivated for their fruit, and as the only one that may be said to be likely to play a part of positive importance in the reconstitution of vineyards of the Mediterranean region—a fact that amply justifies the favor with which it is regarded by viticulturists, and the high price at which its cuttings are held.

Herbemont.—There has been no synonym in France for this variety. It is characterized in the following manner: Plant vigorous. Aspect semi-erect; more spreading than the *Jacquez*. Canes long and strong. Leaves three or five-lobed, of a rather dark green, and glabrous on the upper side; of a pale green with rigid and thick hair on the veins beneath. Bunch large, long, shouldered, compact. Berry small, bluish black.

Like the *Jacquez*, the *Herbemont* is a variety whose resistance was long since established. Its wine, lighter than that of the former, has, when it comes from suitable conditions, substantial qualities. Unfortunately its color, much less intense than that of the wine of *Jacquez*, prevents its competing with it in southern markets. Moreover, the *Herbemont* bears its fruit rather late, and its produce, regarded as very considerable by the Americans, who are not accustomed to the large vintages of our European vines, is inferior to that of the *Jacquez*. Moreover, the extremities of its canes are often insufficiently ripened.

Notwithstanding the inconvenience which we have just pointed out, rendering it inferior to the last variety, the *Herbemont* would yet play an important role in the reconstitution of southern vineyards were it not for the limited number of soils in which it is possible for it to thrive in the Mediterranean climate only. It seems thus far that there is in this region pebbly soil, permeable, easy to heat, and preserving nevertheless a certain freshness during the Summer, which alone allow it to vegetate vigorously and without chlorose. Soil of silicious or calcareous gravel, colored red by peroxyd of iron, as Mr. Vialla has demonstrated, is very suitable for it. The *Herbemont* ripens at nearly the same time as the *Jacquez;* but being less subject to anthracnose than the latter, it might probably go further north than it, provided that it be cultivated on well-exposed hill-sides. The *Herbemont* is more difficult to root by cuttings than the *Jacquez.* However, when it is cultivated under favorable conditions, sufficient results (from sixty to seventy per cent.) may yet be obtained from this mode of multiplication.

Upon the whole, although this variety seems destined to remain in our southern vineyards, it does not seem called upon to play a part there nearly so important as the *Jacquez.*

Black-July, sometimes designated by the names *Devereux* or *Lenoir* (Bush).—This variety, which is not yet much propagated in France, is nevertheless appreciated there, and tends to spread. It possesses the following characteristics: Plant very vigorous. Aspect spreading; a little less so than that of the *Cunningham.* Canes long, of medium thickness; branches numerous. Leaves (full grown) of medium size; entire or scarcely trilobate; of a rather dark green and nearly glabrous on the upper side, with a very few hairs on the veins; of a paler green, with short hairs in rather thick tufts on the veins of the under side; (young) distinctly trilobate, a little white on both sides, quite roseate on the edges. Bunch small, compact. Berry small, of a deep bluish black.

The wine from the *Black-July,* without having the color of that from the *Jacquez,* nor the fineness of that from the *Herbemont,* may be considered ordinarily as a tolerably good red wine. Unfortunately the small amount of bunches and of berries of this variety prevents a very considerable production being obtained from it. Less subject to chlorose than the *Herbemont,* but more so, however, than the *Jacquez,* it seems to adapt itself to all soils that are not too humid nor too cold. The period of maturity of its fruit seems a little later than that of the *Jacquez* and *Herbemont.* It takes root easily by cuttings.

Cunningham.—Not one of the synonymous names that are given to it in America is used in France. It is, after the *Herbemont* and *Jacquez,* the most propagated of all the *Æstivalis* in European culture. It presents very great analogies with the *Black-July,* and forms with it a group characterized by its small and compact bunches, and entire, or nearly entire, leaves, which might be opposed to that with large bunches and lobate leaves, to which the *Jacquez* and *Herbemont* belong.

The characteristics of this variety are the following: Plant very vigorous. Aspect spreading. Canes long and branched. Leaves (full grown) large, entire, or slightly trilobate; leaf-stalk indentation generally closed; two series of notches, generally tapering; slightly honeycombed between the veins; of a dark green and with a very light down on the upper side; of a whitish green, and covered with long hairs on veins, on the under side; (young) distinctly trilobate, villous, and white on both sides. Bunch very compact, of medium size, often shouldered. Berry small, black, a little grayish.

The wine from the *Cunningham,* which is rich in alcohol and presents certain qualities, unfortunately is wanting in color.[1] Therefore only white wines can be made from it, which, well prepared, are certainly valuable, only the insufficient fertility of this variety prevents its being produced very advantageously.

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[1] See Appendix, note two.

The *Cunningham* appears to adapt itself to almost all natures of soil, provided always that they be not unduly humid and cold. This variety of the *Æstivalis*, with the *Jacquez*, possesses the greatest elasticity in this respect. It even appears to thrive better than the latter in the dry and pebbly soil of the hill-sides. It prospers better than any other, especially in the soil of ferruginous, washed pebbles of the Alpine Diluvium. Its maturation, unhappily later than that of the other varieties which we have just examined, will allow it to be cultivated, outside of the extreme South, only on well exposed hill-sides. The *Cunningham* is at least as difficult as the *Herbemont* to root by cuttings—a fact that will probably prevent it from playing the important part to which its remarkable qualifications as a grafting-stock would call it.

B. VARIETIES OF V. RIPARIA. As the varieties of *V. Æstivalis* appear more especially destined to be cultivated for their fruit, those of *V. Riparia* seem obliged to play almost exclusively the part of grafting-stocks. In fact, whereas the peculiar taste of their fruit and their ordinary fertility preclude the thought of seeking to obtain wine from them directly, the facility of their taking root by cuttings, the relative low price of their canes, the rank growth of most of them, in short, the facility with which they favor ingraftment of most of our old European varieties, insures them the first rank for this purpose.

The varieties of this species which practical use appears to have adopted without question are the following: 1. The divers varieties of the wild *V. Riparia;* 2. *Solonis;* 3. *Clinton;* 4. *Taylor;* 5. *Vialla;* 6. *Franklin.* We might add yet to this list the *Elvira*, the *Noah*, and perhaps even others which belong to the same stock, and which, although hitherto little known, will probably be widely spread on account of their resistance and vigor.

Wild V. Riparia.—Cuttings of wild *Riparia* have been imported from America in great quantity for several years. They come to Europe from the woods of Missouri, of Kansas, and of Iowa; from the northern boundaries of Indiana, and even from Texas. Therefore, thanks to the possibility of procuring cuttings of this species at little cost, and in almost unlimited quantity; thanks, moreover, to the usually rank growth of the plants derived from them, and to their great resistance to the attacks of phylloxera, it is probable that this species will occupy an important place in European vineyards.

On account of the multiplication by seeds which is spontaneously effected in the woods, and of the hybridization that takes place among the diverse varieties, the wild varieties of *V. Riparia* are very numerous; we could count almost as many of them as of the parent stock; and it would be impossible and of no practical interest to examine all the kinds already known in France. However, taking into consideration their principal characteristics and fitness for cultivation, they may be grouped in four principal varieties: 1. The downy wild *V. Riparia;* 2. Wild *V. Riparia,* glabrous, with thin leaves; 3. Wild *V. Riparia*, glabrous, with thick leaves; 4. Wild *V. Riparia*, with small leaves.

The downy *V. Riparia* have their leaves and young branches covered with down in their infancy. These are generally vigorous plants, the cane of which, with its large diameter, offers a robust subject for ingraftment. Not particular as to the nature of the soil; they dislike only white clay entirely sterile, or excessively humid soil; still they thrive better in these last than the glabrous *Riparia* with thin leaves.

The glabrous *V. Riparia*, with thin leaves, are characterized by their leaves being destitute of hairs on the upper surface from their infancy; and sometimes completely glabrous; sometimes invested with a few bristles on the under side, and on the veins only. The leaf, thinner than in those which we have classified as having thick leaves, is also generally of a lighter green, and not so glossy. They are for the most part remarkable for the great strength which their roots acquire very early, and for the small number of phylloxeras found on them. More subject to chlorose than those of the downy variety, they should in preference be put in very healthy and not too clayey soil. The variety sold under the names *Riparia Fabre, R. Martin des Pallières*, and highly esteemed by some viticulturists, belongs to this type.

The glabrous *V. Riparia* with thick leaves, which are perhaps the result of an hybridization of *V. Riparia* and *V. Cordifolia*, have glabrous leaves, thicker and glossier than those of the preceding variety; they are also generally shorter and not so deeply dentated. This type, of which might be given, for example, the variety inaccurately named *Scupernon* (*sic*), of the Acclimating Garden, and that numbered thirteen in Mr. Meissner's collection of *V. Riparia*, appears remarkable for its resistance to chlorose.

As for the wild *V. Riparia* with small leaves, they usually give rise to sickly plants, very subject to the worst forms of chlorose. They should therefore be carefully eliminated from cultivation.

On the whole, the wild *V. Riparia*, with the exception of those last mentioned, may be considered as excellent grafting stocks, very resistant to phylloxera, and susceptible of living in nearly all soils, saving that which is too heavy and too humid, on condition of choosing amongst them the varieties most suitable to the soil in which they are planted.

Solonis.—*V. Solonis* is probably a wild variety of *V. Riparia.* It has been cultivated for a long time in botanical gardens of Europe; but up to the present time it has not been found in the woods of the United States; therefore, it can be procured only in less quantity, and at higher prices than the other wild varieties of the same species. As on the other hand, it possesses particular characteristics and special aptitudes, we believed that it should be separated, considering it in a practical point of view, from the wild *V. Riparia.*

Its principal characteristics are the following: Plant vigorous, of spreading aspect. Canes long, with internodes of average length, almost cylindrical, hardly sinuous. Branches numerous and long, covered with a light down towards the extremities, and preserving cobwebbed traces after ripening. Leaves of medium size, entire; two rows of acute teeth, some of them a little longer, marking lobes;

those which indicate the lower lobes generally converge towards the axis of the leaf; leaves slightly plicated, with the extremity bent over on the under side. The young leaves are covered beneath and on top with a whitish down; full grown—they are of a glaucous green on the upper side, with prickly hairs on the under side, which is a little paler. Bunch small, tolerably compact. Berries small, black.

The *Solonis* is certainly one of the types offering the greatest guaranties as to resistance; it has long been cultivated with success, and in the midst of phylloxera at Mr. Laliman's, at Bordeaux, and the wounds produced on its roots are of so little importance, that it was at first believed wholly resistant. It may be classed, in this respect, as one of the best varieties now adopted in practical use. Endowed with remarkable vigor, and susceptible of considerable development in localities suitable for it, it fosters the ingraftment of most of our French varieties very well.

But little addicted to chlorose, it grows better than any other variety of wild *V. Riparia* in soil that is humid and even a little salty. On the contrary, it seems to dislike the dry and burning soils in the South, where it frequently loses its leaves, scorched by the sun's rays; only anthracnose is to be feared in humid climates such as that of Beaujolais.

The *Solonis* has been condemned for being difficult to propagate by cuttings; in fact its large canes do take root with difficulty, but those of medium or small size, well preserved and planted under suitable conditions, thrive in considerable proportions (eighty or eighty-five per cent).

As may be judged from the preceding, the *Solonis* may be considered as pre-eminently the grafting-stock of low lands, where the wild *Riparia* would be in danger of suffering from excessive humidity.[1]

Clinton.—The *Clinton* was one of the first varieties imported into Europe at the beginning of our experiments on American vines. According to Americans, who esteem it highly and cultivate it on a large scale for its fruit, it was received from the first with exaggerated favor; it furnished, said one, an excellent wine, qualified for consumption in France; moreover it should serve as a universal grafting-stock, and suffice in itself for all requirements involved in the reconstitution of European vineyards. Unhappily numerous checks met with in the South, from its being planted in soil unsuitable to it, caused a veritable panic in its respect. Its resistance, very true and proved by many and comparatively old experiments, was contested, and it fell into disrepute as unjustifiable as the infatuation of which it had been the object. It is now regarded with less prejudice, and consequently greater justice. Although it gives a wine remarkable for its color and richness in alcohol, it is not cultivated for its fruit, owing to its small vintage and peculiar taste; and if it is recognized as a good grafting-stock for some of our southern varieties (especially the *Aramon*) it is likewise regarded as adaptable (in the Mediteranean region, however) to but a limited number of soils.

The *Clinton* is characterized as follows: Plant vigorous, spreading. Canes long and slender, with elongated internodes. Leaves of medium size, generally entire and heart-shaped, sometimes trilobate; of a rather dark green and glabrous on top; of a little paler green, with bristly hairs on the veins, on the under side; young leaves slightly woolly. Bunch medium or small, compact, not shouldered. Berry small, black.

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[1] Under these conditions perhaps the *V. Cinerea* will some day be preferred to it, but at present it is too little known, as regards facility of propagation by cuttings and as a grafting stock, to enable us to advise its being put to this use.

The *Clinton* is very subject to chlorose, especially in heavy, cold, and humid ground, in shallow soil, and in calcareous regions. It grows best, and should be cultivated only in medium or light soil, pervious and fresh. Red silicious soil is particularly favorable to it. It takes root very easily by cuttings, at least as easily as our European vines; therefore, taking into consideration this property, its value as grafting-stock, and the low price and abundance of its cuttings, it may be considered that it will have a very important place in the vineyards of localities wherein it thrives well.

Taylor.—The *Taylor* has been regarded with the same fluctuating opinions, though in less proportions, as the *Clinton;* too highly extolled at the outset, then too much abased, it is now regarded, as it deserves, as an excellent grafting-stock in suitable localities.

It somewhat resembles the variety we have just spoken of; it is easy, however, to distinguish it from the latter, by the young leaves on the extremities of its branches, which are entirely glabrous. However, here is the description: Plant vigorous, spreading. Stock robust. Canes long, with internodes of average length, of medium diameter, scarcely sinuous, with numerous and long branches. Leaves pretty large, almost entire, slightly trilobate; leaf stalk indentation rather open; two series of rather acute notches; glabrous on both sides; of a beautiful green on the upper side; light green underneath. The part where the veins diverge is generally roseate. Leaves slightly channelled. Bunch small, often not setting well. Berry small, amber white.

The vigor of the *Taylor* when it is planted under favorable conditions, the considerable diameter promptly acquired by its stock, the facility with which its cuttings take root, and its suitability for nourishing our different French varieties, render it a grafting-stock of the first order. Unfortunately, like the *Clinton*, though in a less degree, it is far from thriving everywhere. Lands too clayey, too pebbly, too humid and cold, or too dry, are unfavorable for it. When, on the contrary, it is planted in soil of medium consistency, or even somewhat heavy, provided it be well drained, or in light but fresh ground, it may be regarded as one of the best grafting-stocks that may be used. Moreover, it can now be procured very easily and very cheap.

Vialla and Franklin.—Although these may be considered as two distinct varieties, their characteristics and aptitudes are so much alike that it is difficult to separate them, which is of no practical importance however. Therefore we shall study them together. Although both of them belong to the group of *V. Riparia,* they nevertheless bear many traces of hybridization, probably with the *V. Labrusca,* many characteristics of which, especially the continuity of the tendrils, have been preserved in them. They may be described as follows: Plant vigorous, spreading. Canes vigorous, of medium diameter; when young, those of the *Vialla* are bluish purple; those of the *Franklin,* green. Leaves rather large, entire, of a deep green, and almost glabrous on the upper side; of a lighter green, and adorned with down more or less light, on the under side; with slightly marked obtuse notches. Bunches small, not shouldered, nearly always loose in consequence of the dropping of the berries. Berries small, spherical, with pulpous and foxy flesh, deep prune black.

The *Vialla* and *Franklin* are not fit to be cultivated for their fruit, the foxy taste of the grapes and their tendency to set badly preventing their being utilized for that purpose; but by way of compensation, they make excellent grafting-stocks; vigorous, not subject to chlorose, and thriving in most all soils.

Besides these varieties, adopted without question in practical use, several others are found, as we have said, which eventually will probably occupy an important place among grafting-stocks; for example, the *Elvira*, a hybrid of the *Taylor* and *Grandnoir* (of the Acclimating Garden). This variety, remarkable for its vigor, its resistance to phylloxera, and slight propensity to chlorose, will almost certainly be called in consequence to serve as subject for our European vines, although it may be qualified to furnish a tolerably good white wine. In this it will probably resemble the *Noah*, a recently imported hybrid, which is closely allied to the *Vialla* in its forms and aptitudes, and perhaps in other ways not yet as well known.

C. VARIETIES OF V. RUPESTRIS. The varieties of the *V. Rupestris* are all wild, and are too little known to enable us to determine their special aptitudes. All that we know is that *V. Rupestris* generally thrive, even in dry and arid lands, and in sandy, pebbly, and calcareous soil, where the wild *V. Riparia* could not live.

Not subject to chlorose, only intense heat of the sun is to be avoided, as it marks the leaves with numerous spots and causes them to drop off. This fact is of no importance, however, as they are necessarily called upon to serve as grafting stock; in fact, the fruit of the fertile plants is much too small and scarce for one to dream of making any other use of them, and the first practical attempts at grafting upon them have so far yielded satisfactory results. Their rooting, by cuttings, may be compared to that of the *Solonis;* as in the last variety, medium or small cuttings must be used in preference to large ones.

D. VARIETIES OF V. LABRUSCA. The varieties of *V. Labrusca* seem but little qualified to fill an important place in European vineyards; their resistance to phylloxera, although superior to that of our European vines, is nevertheless inferior to that of other American species, and if some of them are able to preserve a sufficiently healthy state amidst the attack of the insect, others, on the contrary (for example, the *Isabella* and *Catawba*), end by succumbing to it. Moreover, they are usually of difficult adaptation, requiring in general fresh soil and a somewhat humid climate. Finally, the foxy taste of the grapes absolutely prevents any advantage being derived from cultivating them for their fruit.

They may therefore be used only as grafting-stocks, and two varieties only have been cultivated in Europe for this purpose; they are the *Concord* and *York Madeira;* yet this last is not a pure *V. Labrusca*, but a hybrid, as it shows the discontinuous arrangement of tendrils, and many other characteristics which would take too much time to enumerate here. We shall therefore confine ourselves, in this group, to the study of these two varieties.

Concord.—The *Concord*, which was at first imported to us in very great abundance, on account of the esteem in which it was held by the Americans, has proved itself very deceptive, owing to the limited number of localities in which it can grow. Its characteristics are the following: Plant tolerably vigorous, spreading canes of medium diameter, long, with numerous branches. Leaves somewhat thick, of a dark green and almost glabrous on top; covered with a felt like down; at first whitish, then rust colored, on the under side. Bunch large, shouldered, a little compact. Berries large, globular, black, of a prune tint, with very apparent foxy taste and pulpy flesh.

Notwithstanding the many repulses which the cultivation of the *Concord* has met with, its resistance is beyond doubt; for eight years it has persisted in the midst of phylloxera, in certain localities in France. Failures in its respect are due solely to its tendency to chlorose which allows it to develop satisfactorily in the south, only in silicious and ferruginous soil, such as the washed pebbles of the *Alpine Diluvium*, or in similar localities. Unhappily, even in suitable places, it seems inferior to the divers varieties of the *V. Riparia* as a grafting-stock. Under these conditions, it is not probable that the cultivation of this variety will be much increased in the future; good grafting-stocks are too easily obtained nowadays to prevent its being almost wholly abandoned.

York-Madeira.—The *York-Madeira* is evidently, as we said before, a hybrid of *V. Labrusca*, and not a pure *V. Labrusca.* It was one of the first American varieties introduced into Europe. We have seen plants of this cultivated for twenty-five and thirty years, in many collections. The following description may be given of it: Plant of average vigor, slender, spreading. Canes slender, long, with internodes of medium length or short, with discontinuous tendrils. Leaves medium, entire, of a rather dark green, glabrous on the upper surface, adorned on the under side with a rather thick woolly down; two rows of indentations, generally short and obtuse. Bunch small, cylindrical, or in the form of a conical cylinder. Berries rather small, spherical; of a deep prune black, with pulpy flesh and foxy taste.

From being crossed with another species this variety seems to have acquired qualities of resistance and a rank growth that have attracted the attention of a good many experienced viticulturists. Very resistant to chlorose, it thrives in nearly all places, and especially in the bad, calcareous, pebbly and arid soils, where its place will be a marked one if experiment will give it a sufficiently practical value. Unhappily the foxy taste of its fruit renders it absolutely unfit to be cultivated for the grapes. Its value as grafting stock is not very well known as yet, but it seems that its paltry growth will render it more suitable for the varieties of the northern vineyards than for our very vigorous varieties of the South.

CHAPTER II.

CHOICE OF VARIETIES WITH REGARD TO THEIR DESTINY AND TO LOCALITIES.

The viticulturist engaged in using American vines for the reconstitution of a vineyard, finds himself face to face with divers questions to examine before deciding upon such and such variety, although he knows its resistance. Is it to my interest to plant for the sake of the vintage? Is it better to use grafting stocks? And among the varieties he has chosen, which will be best adapted to the soil around him, to the climate he lives in?

These are the divers problems which we shall endeavor to solve in this chapter, grouping in a form more convenient for this study, the information previously given on the principal American varieties, and completing it when expedient.

1. Use of Varieties for the sake of the Vintage, or for Grafting Stocks.

The tendency predominating in viticulture in general, but more especially in that of southern France, and which may be considered, however, as the consequence of actually economical conditions, is to produce, as abundantly as possible, very cheap wines, without much concern as to their quality. Thanks to the facility of transportation, we may reach the great mass of consumers and assure ourselves of the rather extended openings for maintaining sufficiently remunerative prices.

In this respect, not one of the American varieties qualified to be cultivated for wine, would be able to replace our old southern varieties of large vintage, and we cannot think to preserve their abundant harvests, except by grafting them on resistant American stocks. This solution, therefore, will necessarily be the most general one, especially if we consider, moreover, that it affords room for returning to conditions long since known for continuing to furnish to commerce the types of wine to which it is accustomed, and for avoiding many experiments and contingent risks necessarily involved in the employment of new varieties. We must not lose sight of the fact, nevertheless, that the excessive vintages obtained by means of very fertile varieties are always more or less bought at the price of a great diminution in the color and alcoholic quality of the wines, properties to which commerce attaches great value. From this arises the growing importance attached to the production of wines for blending purposes in some of our southern vineyards. Now, if the American vines, cultivated for the sake of their fruit, cannot furnish us with an abundance of wine, one of them, the *Jacquez*, yields a very remarkable wine for blending, and that, too, even in low soils, rich and fresh, which seem the least likely to furnish these qualities; therefore this variety will probably be called upon to play a part of certain, though secondary, importance in the reconstitution of European vineyards. It will be planted in a quantity proportionate to the weakness of the vines which it is intended to strengthen, and each proprietor will be able to mix the wine in his vat, which was hitherto done only by the merchant.

Therefore, except in special cases where, on account of the production of wines, well characterized and of superior commercial value, we cannot do otherwise than graft the long used varieties on American stock; it seems difficult to adopt a unique system; grafting will probably predominate greatly, but will be nearly always accompanied, in varied proportions, by the cultivation of the *Jacquez* for the sake of its fruit.

If the *Jacquez* seems marked in most cases as the variety that must be preferred for cultivation for fruit, there is, on the contrary, a wider choice as regards grafting stocks. The qualities that must be sought for in them, besides suitable adaptation to the locality for which they are destined, are the following: 1. Facility of propagation by cuttings; 2. Relative cheapness; 3. Sufficient vigor.

We shall see in what measure the diverse types we have previously studied, realize these conditions. As regards the facility of propagating them by cuttings, they may be classed as follows: 1. *Clinton* and *Taylor*, very easy; 2. wild *V. Riparia*, *Franklin*, *Vialla*, and *Elvira*, easy; 3. *York-Madeira*, tolerably easy; 4. *Solonis* and *V. Rupestris*, requiring some precautions which we have pointed out.

The variations in price from one year to another, and the diverse conditions under which they are sold, precludes a very precise statement of the relation existing between the market values of the diverse varieties; in this respect, however, they may be considered as generally grouped thus: 1. *Clinton*, *Taylor*, and wild *V. Riparia*, cheapest; 2. *Vialla*, *Franklin*, *V. Rupestris*, dearer; 3. *York-Maderia*, *Solonis*, and *Elvira*, dearest. As for the varieties with which we are occupied, it may be considered as varying a good deal according as the locality wherein they are planted is favorable for them; but supposing them all in the best conditions for success, they might be ranged approximately in the following order: 1. *Taylor*, *Elvira*, and *Solonis*; 2. wild *V. Riparia*, *Clinton*, and *Vialla*; 3. *V. Rupestris* and *York*. Finally, there might yet remain an important point to examine, namely, the aptitude of the grafting-stock for sustaining such and such a French variety, in view of which it was planted. Unfortunately this question, which is now being studied, is not yet sufficiently solved to enable us to give precise and definite information on this point.

However, we have already observed good grafts of *Aramon*, *Carignane*, *Petit Bouschet*, *Terret-noir*, *Cinsaut*, *Morrastel*, etc., on the *Clinton*. We have noticed that, although the *Aramon* developed sufficiently on the *Taylor*, it did not prosper so well on it as on the *Clinton*, but the French varieties mentioned above, and also the *Terret-Bourret*, *Chasselas*, *Muscats*, *Olivette*, etc., thrive extremely well on it. The *Solonis*, rarely grafted on until now, nourishes the *Petit Bouschet* and *Aramon* very well.

Excellent results have been obtained with the *Aramon*, *Carignane*, *Aspirant* and *Cinsaut* on the wild *V. Riparia*. But however important may be the elements we have just considered, the choice of varieties for cultivation cannot depend solely on the more or less complete union among some of them; it is necessarily subordinate to the possibility of adaptation of these varieties to the soil and climate in which they are to be planted. It is this last question that we are now going to examine.

2. *Adaptation to the Soil.*

Our knowledge on this important point is still very imperfect; it is, we know, only after long and repeated experiments that we can give a fair account of all the conditions of the soil necessary for each variety, and the years we have cultivated American vines on a somewhat large scale, have been too few in number for the studies commenced on these matters to be completed. We shall therefore limit ourselves to giving here what is known on this subject, without pretending to treat it completely.

An important fact to which Mr. L. Vialla, President of the Agricultural Society of Hérault, has drawn attention, and on which all viticulturists are now agreed, is that in a soil of a silicious nature, and colored red by peroxyd iron, all American varieties maintain a most satisfactory state of health, and acquire all the development compatible with the richness of the soil. But many of these varieties do not need land of that nature in order to prosper, and those very ones that seem to thrive the best there, can likewise develop satisfactorily in some other localities. We shall, therefore, endeavor to sum up the information we have been able to gather on this question.

According to our observations, the following varieties may generally be cultivated in the soil given below:

First—Deep, alluvial soil, rich and somewhat humid: *Cunningham*, *Jacquez*, *Solonis*.

Second—Deep soils, somewhat heavy, but easily drained, either on account of their situation, or the nature of the sub-soil: *Cunningham*, *Jacquez*, *Herbemont* (especially if they are colored red and pebbly), *Solonis*, wild downy *V. Riparia*, *V. Riparia* with thick and glossy leaves.

Third—Deep soil, of medium consistency, well drained, not drying up too much in summer: *Jacquez*, *Cunningham*, *Black July*, *Solonis*, wild *V. Riparia* (the various good varieties), *Vialla*, *Franklin*, *Elvira*, *Taylor*.

Fourth—Light soils, pebbly, deep, well drained, and preserving a sufficient proportion of water in summer: *Jacquez*, *Cunningham*, *Herbemont*, *Clinton*, and *Concord* (especially if they are colored red by peroxyd iron, and are not calcareous for the last two), *Vialla*, *Franklin*, *Taylor*, *V. Riparia* (wild, the various good varieties), *V. Rupestris*.

Fifth—Light soil, pebbly, calcareous, dry, and arid: *V. Riparia*, wild (the divers varieties), *V. Rupestris*, *York-Madeira*.

Although these directions may be considered as true in a general way, and though we have great chances for success in following them up, it will be noticed that they are still incomplete. It was necessary to pass over in silence a good number of interesting soils, in which no observation has yet been made; moreover, they are not as precise as could be desired, because the causes that permit or hinder success in such and such soil are not sufficiently known to enable us to trace exactly the limits of their action. Under these conditions, the directions which we have given above should be especially considered as serving to circumscribe the field of experiments to be made on a place. Small collections, composed of varieties that appear, from what we have stated, able to thrive best in the locality which it is desired to plant, and set out in the divers cultivable soils desired to be used for vineyards, are the surest means of fixing one's choice.

3. *Adaptation to Climate.*

Climate, which is the result, not only of the general geographical situation but also of certain topographical elements, such as altitude and exposure, can influence the choice of varieties in two ways: First, it can prevent the cultivation of vines raised for sake of the vintage which ripen their fruit only in certain limits of temperature, or which are exposed to certain atmospherical conditions dangerous for them; second, it weakens the influence of certain physical properties of the soil, and consequently modifies the chances for success or failure of some varieties in a given locality.

Considering the first point we mentioned, vines cultivated for the sake of their fruit, all of which belong, as we have seen, to the group of *V. Æstivalis*, may be considered as southern plants. None, saving perhaps the *Eumelan*, which we have not spoken of because it is little propagated and not well known, would probably be able, under ordinary conditions, to go north of the department of the Drôme, nor attain a very considerable altitude. The very late maturity of their fruit, the insufficient ripening of their canes, and the attacks of anthracnose (especially in the *Jacquez*), oppose their practical utilization beyond these limits.

As for grafting-stocks, the direct influence of climate cannot reach them, their purely underground rôle screening them completely.

Climate, as we have seen, also helps to modify the adaptation of certain varities to diverse natures of soil. It is thus that varieties of difficult adaptation in Languedoc and Provence, thrive in the greatest number of soils, when transferred to places where the atmosphere is more humid, in Dauphiné or Bordelais, for example, or yet in the groves of Cévennes. Under such conditions the choice of varieties will be notably easier, and much less limited than when we have to study adaptation to the soil.

B. PROCESSES OF MULTIPLICATION.

CHAPTER III.

PROCESSES OF MULTIPLICATION APPLICABLE TO THE VINE—THE SEED-PLAT.

The vine, like most of the higher order of vegetables, can be multiplied by seeds, and by the divers processes of segments, cuttings, layers, and grafts. All of these processes have not the same value, in every case, for the practitioner, and the success of a plantation often depends upon the intelligent employment of that one of them which is best suited to the given circumstances, and the end proposed to be attained. We are, therefore, going to review them successively, examining the applications of which they are susceptible, and the care that must attend their employment.

SEEDS.—The vine seeds may be destined to attain two distinct ends: First, the creation of new varieties; second, the production of resistant grafting-stocks.

The obtainment of new varieties is a work of time, which is hardly in reach of most viticulturists endeavoring to arrive as soon as possible at a sure and known product. Nevertheless, it presents a certain interest; the Americans have gained by this means, in a relatively inconsiderable number of years, a good many meritorious varieties, issues of their wild types; therefore, have we deemed it expedient to say a word to men of good will, disposed to attempt endowing viticulture with varieties that are new and perhaps better adapted to our special conditions.

Whereas the divers processes of multiplication by segmentation are confined to putting fragments of a vine in conditions that allow it to prolong an existence commenced in common with the parent stock, without material change in its character, that by seeds produces new vines, differing, to some extent, from those the seeds came from, although connected with them by certain characteristics. For example, many are infertile or inferior to those from which they originated, which prevents a fair use of this mode of reproduction in the case of vines cultivated for the sake of their fruit. But this variation, which is an insurmountable obstacle when the preservation of a settled type is at stake, becomes a condition of success when, on the contrary, it is desired to create new ones. The viticulturist chooses among the new varieties thus produced those that appear to be best adapted to his purposes, or most resistant, and then preserves them, propagating them by one of the methods of segmentation.

If the variations in the seedlings are too frequent and too considerable to enable us to count upon this method for the production of fruit, we may, however, by taking certain precautions, prevent these modifications from extending to the peculiar radical constitution of the species upon which the resistance depends. This method may, therefore, be of advantage as a means of creating grafting-stocks for our French varieties, especially in regions as yet free from phylloxera, where the introduction of rooted plants would be dangerous, and that of cuttings is impossible.

A. Choice of Varieties.—With respect to the creation of new types, it is to our interest to employ cultivated varieties that already present a certain number of desirable characteristics, but in which they are not so firmly established as in the wild types, and which are more likely in consequence to furnish some descendants which, although preserving the good qualities that caused them to be chosen, acquire others besides. We may also, by hybridization among species or varieties partially offering on both sides the qualities we would wish to see united in the same plant, seek to obtain an intermediate product possessing them all. For example, we will fertilize an American *V. Æstivalis* resistant and bearing small fruit, by a French variety not resistant and of large fruit. Certainly a very large number of the vines obtained in this way will be especially allied to one of their ancestors, and will be defective, either through the small size of the fruit, their infertility, or in some other respect; but it is possible to find one of the number in which all of the good qualities of its parents will be accumulated. The *Jacquez* probably originated in this way. The crossings that can apparently be made with the greatest chances of success are those between *V. Æstivalis* and *V. Vinifera*, or *V. Rupestris* and *V. Vinifera*, neither of them possessing the foxy taste which nearly always persists in descendants.

This hybridization is effected in the following manner: The flower of the vine presents a peculiar arrangement; its petals, instead of opening on top, are detached from the calyx at their base, and remain gathered together, forming a sort of bonnet or hood, which keeps the anthers in contact with the pistil for some time; it is during this time that fertilization takes place; the hood should, therefore, be taken off each flower before the time when the petals are detached; we can then rest assured that not a trace of pollen has left the anthers; the stamens are then removed to take away all chance of subsequent fertilization through them; then full blown flowers of the variety which must act as male are brought and held over the first in such a way as to cause them to deposit on them a portion of the fertilizing dust. Finally, the fertilized clusters are enveloped with a covering of gauze, to prevent foreign pollen coming to them. When there is discordance in the time of blossoming, that of the late variety may be advanced by putting a vine under a glass box, and that of the early variety retarded by sheltering it on the south side with boards or straw, and inclosing the clusters of flowers in sacks of white paper.

Fertilization once effected, it is well to take divers precautions to prevent the dropping which may result, either from the washing away of the pollen by the rains, or from accidental cooling of the atmosphere. To ward off the first danger, the protective sacks may be kept inflated by means of a brace of iron wire fixed inside, and protected with a little paper cap, dipped in linseed oil. The second is combated quite efficaciously by repeated applications of sulphur just as fertilization is commenced, and by annular incision.

Apart from the seeds coming directly from hybridization, we might be tempted to utilize the considerable variations of those produced by hybrid plants; unfortunately their descendants reproduce more or less the old types from which the plant itself came; it is, therefore, of no interest to use them.

When seeds are used with a view of creating grafting-stocks, we seek, on the contrary, to avoid variations as much as possible, in order not to risk losing the faculty of resistance to phylloxera, which constitutes the only reason for raising them. We should therefore direct our attention to the wild types, long use of which has naturally firmly established the principal characteristics, and choose among them those whose very precocious florescence renders impossible all chances of spontaneous fertilization by less resistant species. The wild *V. Riparia* and the *Solonis* seem to comply with these conditions as well as possible; experiment, however, has proved the remarkable permanence of the general character of these vines in their seedlings. Therefore we think it will be well to use only these when we cannot make a selection with respect to resistance, in planting in a phylloxerated district.[1]

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[1] It is easy for persons living in indemnified countries, to send numerous cuttings of the parent stocks of their seedlings to the phylloxerated countries, that their resistance may be tested there.

B. Choice of Seeds. The grape seeds destined for the production of seedlings, should be of the preceding vintage, and have been gathered when the grapes were perfectly ripe. Experience has proved that those that fermented with the must thrive in the same proportion as those extracted directly from the fruit, therefore no special precaution is necessary in this respect.

C. Preparation of Seeds. Seeds put into the ground without previous preparation usually germinate in an irregular successive manner; to avoid this inconvenience they must be stratified, throughout the Winter, in sand, and sprinkled slightly during March. When the seeds are received too late to admit of this method, they may be simply soaked in pure water for three or four days; however, stratification must be considered preferable.

D. Sowing the Seeds. Seeds are sown in April, so that the young plants may have nothing to fear from frosts after they have come up. Seeds are sown at a depth of from one to one and one half inches, in level ground, which must first be properly fertilized and covered with from two to two and one quarter inches of mould and sand if the soil is somewhat compact. They are sown in rows, from twelve to sixteen inches apart, and at a distance of about six inches at most from each other in the row. It has been noticed that the development during the first year is always proportionate to the space left between the plants. Finally, the bed is covered lightly with short straw or stable manure not decomposed.

E. Care of the Seed Plant. Care of the seed plant consists in sprinkling it every two or three days with a watering-pot, having finely pierced rose, and in weeding it carefully. The plants generally spring up in about a month. The young vines are then rather sensitive to the sun's action; they must not be watered during the warmest part of the day; if necessary, they may even be protected by a light litter of straw.

F. Transplanting. Seedlings of *V. Riparia* frequently attain a height of from four to five feet the first year, those of *V. Æstivalis* hardly exceeding twenty or twenty-four inches in the same length of time; however, they must be transplanted the Winter after the seeds are sown, in order that they may not suffer too much from transplantation.

G. Study and Utilization of Seedlings.—When seeds are sown with a view of obtaining new varieties, the sower endeavors, above all, to advance the florescence of the vines he has obtained; he can then study them with respect to fertility and the value of their fruit. The length of time that must elapse before seedlings yield fruit has been greatly exaggerated; some of them (the *Clinton's* especially), in the agricultural school of Montpellier, have yielded fruit the third year, most of them commencing to bear the fourth or fifth. This period may be hastened by various means, such as layering, arching the canes, removing a ring of the bark, or the ligature of a cane reserved for long wood the following year, or better still, grafting a cane of the young plant on a full grown vine. Generally the fruit is not so large nor so abundant at first as afterwards; the development of its qualities must be favored by a good selection of cuttings, by repeated grafting or layering, by relatively short pruning, and cultivation in good soil.

When the seeds were sown in order to obtain grafting-stocks, the young vines thus produced may be utilized in two ways: Either the stocks themselves may be used directly, or only cuttings taken from them.

Seedlings of varieties of quick growth, such as the wild *V. Riparia*, the *Solonis*, etc., may often be grafted English cleft, or *a cheval*, after the first year; but the inequality in the vigor and aptitudes of each plant risks entailing irregularity in the plantation for which they serve as foundation; it is preferable to use only cuttings taken from parent stocks that have been chosen amongst those most robust and most remarkable for their vegetation.

On the whole, as may be seen from the preceding, propagation by seeds is of practical use only as a means of producing in advance resisting grafting-stocks in indemnified regions; its other applications are more properly in the line of the nurseryman or amateur than that of the viticulturist properly so called.

CHAPTER IV.

PROPAGATION BY CUTTINGS.

Propagation by cuttings is the oldest and most generally used process for reproduction of the vine; it is considered by the majority of viticulturists as so superior to all others, in customary practical use, that some varieties are rejected by them because they are not very favorable for this purpose. In fact, it joins to great simplicity of execution, the property which all methods of segmentation possess, of insuring as far as possible perpetuation of the characteristics of the plant from which the cutting was taken, and sometimes even the tints which distinguish one cane from another of the same stock. The only differences that can be made out between the mother-stock and its descendants result from a diversity of localities, and consist, positively, only in degrees of development and vigor, but do not at all alter the fundamental properties of the original type, such as resistance to phylloxera, taste of the fruit, etc.

The facility with which our old varieties from the *V. Vinifera* multiply by cuttings, contributed greatly to the generalizing of this method in Europe. Since we have had to apply it to American vines, it is found that some of them do not take root easily in this way; but these difficulties, far from causing this mode of multiplication to which we were accustomed to be abandoned, have only urged on the viticulturists to a more complete study for means to insure success. Propagating vines by cuttings usually tends to provoke the development on the cutting of roots that it stands in need of. These roots are produced by the underground evolution of latent buds that, in the air, would have formed canes, or, by cellular swellings, arising from generative layers of the wood, organized and soon lengthening like the others. The whole art of the viticulturist, after choosing cuttings most suitable for producing good subjects, will therefore consist in planting them in conditions best adapted to assure good and speedy development of roots. We shall study successively the following points connected with this mode of reproduction: First, choice of canes intended for cuttings, and care required in preserving and transporting them; second, the best method of propagation by cuttings; third, means of insuring rooting; fourth, where to set them out (planting them in the vineyard or in a nursery).

1. *Choice of Cuttings; Care required in Preserving and Transporting Them.*

A. Choice of Cuttings.—Canes intended for cuttings should not be cut until well ripened. This precaution should be especially observed in the case of certain *V. Æstivalis*, such as the *Herbemont* and *Cunningham*, whose branches do not become woody until late in Winter. Moreover, cuttings from plants attacked with divers cryptogamic diseases, such as anthracnose, mildew, etc., must not be used; generally they are not so well nourished, and moreover risk propagating in the new plantation the evil with which they are attacked.

It has been observed that generally the cuttings of average development, with nodes not far apart, and taken from the middle of the cane, present the greatest chances for rooting, and produce the most fruitful plants, and those that yield the soonest. Large canes do not root as easily, and tend to produce wood rather than fruit; while those that are too slender run the risk of withering before taking root, they are often insufficiently ripened, and generally do not make very vigorous plants.

It is expedient, in the reproduction of vines cultivated for their fruit, to choose in preference canes whose flowers set well, and which have yielded the finest and most abundant fruit. These characteristics, peculiar to the cane, are firmly established by this sort of choice, and thus a notable increase in the production will be obtained. When, on the contrary, it is a question of producing grafting-stocks, it is only necessary to make sure of obtaining vigorous plants, and there is no need of taking these last points into account.

B. Preservation of Cuttings.—In short, canes cut only when it is time to use them, may be regarded as offering most chances of success. In this respect, imported cuttings, and especially those coming from America, are really inferior to those obtained in France, and especially in the very locality where they are to be planted.

Packing Cuttings.—Since, at the present, it is generally necessary to use imported cuttings, we deem it expedient to give a few directions as to the care required in packing them, and the precautions to be taken on their arrival.

In order that cuttings for transportation may be perfectly preserved, they should be packed so that they can neither dry up nor absorb more water than they are in the habit of doing. Drying kills the cutting by depriving it of its natural moisture; as to excess of water, it frequently induces fermentation, or mould, according to the method of packing and the size of the package; then again, when neither of these accidents occurs, the tissues of the wood, swollen with water, dry up very rapidly on exposure, to the air.

Packing them in free, almost dry earth, inclosed in well jointed boxes, realizes about all that is necessary; unfortunately they would weigh too much for us to pack them thus. The best plan, if the cuttings have not too long a distance to go, is to put them in straw hampers, after having wrapped the bases in slightly wet moss. For longer distances the bundles of cuttings may be entirely enveloped in moss or hay, barely softened by moisture, which may be wrapped in dry straw; the whole is inclosed in boxes lined with heavy oiled paper.

Care necessary on their arrival.—On the arrival of packages put up in this way, the cuttings should be soaked for a day or two in water, or else—which is better—laid in damp sand.

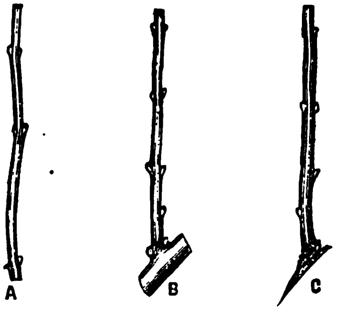
Those forwarded from America are often packed in wet peat-moss, which presents the inconveniences we have pointed out with respect to excessive humidity. If cuttings thus packed, do not appear to have suffered during the voyage, on opening the box, they must be stratified in slightly damp sand, and taken out of it only in small quantities and in proportion as they are needed for planting. Moreover it is prudent to take them to the field in a box containing a little water at the bottom, and to take them out only to plant them.

When the cuttings must be kept some time before setting them out, the surest means of preserving their vitality is to bury them in a heap of sand in a cellar or similar place. When they have to be kept but a short time after being cut, it suffices to immerse the lower part in water.

2. *What sort of Cuttings to Use.*

A. Divers Sorts of Cuttings.—The kinds of cuttings generally used for vines are, the mallet cutting and the ordinary cane of new wood. The mallet cutting is the lower part of a cane having a mallet or piece of wood two years old attached obliquely to the base (Fig. 1 B). The swelling found at the point where the cane unites with the old wood is very rich in latent buds, susceptible of developing under ground into roots. It has long been used almost exclusively on this account; however, it is difficult to plant it with the dibble, owing to the oblique position of the mallet; moreover, the wood of the latter, too old to root well, frequently decays, injuring the health of the plant. It has been suggested, as a remedy for these faults, to do away with the two-year-old wood, leaving only the swelling at the end of the cane (Fig. 1 C); there are then the best chances for success as regards rooting. Unhappily, the present rarity of American cuttings, their high price, and the consequent necessity of utilizing all their parts, from the base to the top, precludes an exclusive use of this sort of cutting, and it is generally necessary to resort to the ordinary cutting of new wood (Fig. 1 A). This last, which is the simplest and easiest to procure, moreover, gives perfectly satisfactory results; it

FIG. 1.

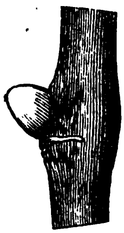


A, ordinary cutting; B, cutting with old wood (mallet cutting); C, cutting with longitudinal sections of old wood.

consists, as its name indicates, of a single fragment of a cane whose length varies according to circumstances.

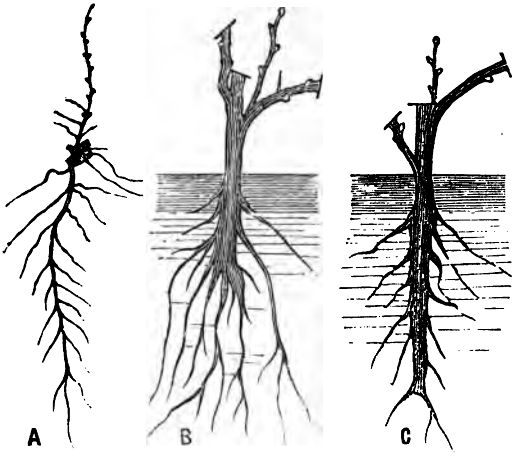
B. Proper Length of Cuttings.—According to rule, and if only the development and good constitution of the forthcoming plant is cared for, the shortest cuttings are the best. Cuttings with a single eye, for instance (Figs. 2 and 3 A), give rise to a cluster of very strong roots continuous with the cane, which assures remarkable vigor to the plant. Very long cuttings, on the contrary (Fig. 3 C), are covered with a great many tufts of roots arranged on each node, not one of which acquires great development, and which diminish in length from top to bottom down to a point where the cane, incapable of putting forth any more, is without apparent vitality, and sometimes ends in dying and partially decomposing. But the question is not so simple as it at first appears. The cutting must be planted in sufficiently wet soil to insure its taking root. Now, in most cases, the requisite freshness is found only at some depth in the soil; whence the necessity of giving the cutting a greater length than at first appears desirable. Cuttings, therefore, should be longer as the soil in which they are to root is drier. Generally their length may vary between six and fourteen inches (Fig. 3 B), the cane not being above the ground more than one or two eyes; in most cases it would be inexpedient to overstep these limits.

Fig. 2.



Single eye cutting, called seed cutting.

Fig. 3.



A, development of single eye cutting; B, development of cutting ordinary length; C, development of cutting made too long.

Independently of the two types we have just mentioned, it has been proposed to use the cutting having a single eye under ground (Fig. 2), and herbaceous cuttings, in order to multiply American vines economically. Unfortunately, when applied to the *V. Æstivalis*, which alone, thanks to their high price, can pay the expenses of hotbed frames, hotbeds, etc., requisite in this method of reproduction in the South, the first does not take root in sufficient proportion for it to be of interest to use it. As to herbaceous (green) cuttings, we can rationally dream of using in this way only the refuse that is cut off in trimming grafts. Set out in light soil, irrigated, and properly shaded, they take root tolerably well, but do not make such thrifty plants as do the good, well-ripened cuttings.

3. Means for Insuring Rooting of Cuttings.

Rooting of cuttings, that is to say, the evolution of their roots, can be effected only in a locality that affords them proper temperature and humidity, but not excessive. The greatest practical difficulty met with in arriving at this result consists in preventing the cutting from drying up before it is able to withstand the waste it undergoes in the atmosphere. Certain American species are particularly refractory in propagation by cuttings, on account of the rather long time existing between the period of development of the buds and the putting forth of the roots, which causes the plant to evaporate very much, so that it can hardly draw any nourishment from the soil. It is thus that, while the *V. Riparia, V. Labrusca, and V. Rupestris* take root easily by cuttings, the *V. Æstivalis*, and especially the *Hermann* and *Norton's Virginia* are more difficult; *V. Candicans* and *V. Rotundifolia* are almost impossible to be obtained by this method.

The means of avoiding this difficulty have been well studied lately, especially in regard to the *V. Æstivalis*, among which are found, as we have seen, varieties of actual value; these means may be classed in two groups: First, those destined to hasten the development of roots; second, those tending to keep the cutting from drying up before it takes root.

To attain the first result we may resort to stratification, soaking, torsion, or *maillochage.*

A. Stratification.—Stratification consists in completely burying the cuttings, during Winter, in light earth, or in damp sand, so that some progress may begin preparatory to the putting forth of roots. It has been suggested to stratify cuttings vertically, and inverted according to the position they were in on the plant; it was thought in this way to induce an afflux of materials towards the top eye, which, returning to its primitive lower place when the cutting is planted, would furnish a greater quantity of nourishment to the roots. Experiments tried in this direction, in the School of Agriculture, of Montpellier, did not appear to give results superior to those obtained from ordinary stratification. When the plants are taken from the sand, the precautions given above on the subject of unpacking should be used to prevent the cuttings drying.

B. Soaking.—Soaking cuttings in water produces analogous effects to those of stratification, only it presents, if continued a little too long, divers inconveniences not found in the last process; in fact the wood is in danger of losing, by masceration, a portion of the soluble materials contained in it, or of rotting; moreover, it should be used only in default of stratification, and not continued more than five or six days.

C. Barking.—Barking is done to induce the formation of excrescent scars of a cellular nature, susceptible of turning into roots. It is done by raising up thongs of bark on that part of the cutting that is to be put under ground, so as to lay bare, in several places, the generative layers of the wood. By torsion, or a slight bruising of the cutting, the same result is attained, but this induces the formation of cracks, by which the water penetrates the pith, which it more or less disorganizes, so that perfectly healthy plants are rarely obtained by these last methods. In short, barking, which, however, has been used a long time in Hérault, is preferable; it can be advantageously applied to stratified canes.

The processes used to prevent drying of the cutting before it takes root, are: irrigation, covering with straw, covering with sand, shading.

D. Irrigation, etc.—Irrigation and covering with straw gives to the soil, or establishes there, the water necessary to preserve the freshness of the cutting; it can hardly be applied in other than nursery culture, but there it greatly augments the chances of rooting. Irrigation should be practiced by infiltration, and, moderately, when it is used in rather compact soil especially; there is danger of the canes rotting if the amount of water is too great at first.

Entirely covering the cutting with sand retards the vegetation of the exterior buds, and consequently the appearance of leaves, which are the principal organs of evaporation, without lessening that of the roots; moreover, it prevents dessication of the cutting itself, and of the soil in which it is planted. Each cutting is surrounded with a little conical mound, if the vines are a little apart from each other; in the opposite case, they are covered with a regular continuous ridge following the direction of the row.

Shade diminishes greatly the waste of water through the leaves; it may be produced, either by means of basket-work, or by setting out the plants under trees whose foliage is not too thick; the luminous green rays, which are almost the only ones coming through the leaves are, in fact, not very favorable to evaporation.

We must always remember that if shade facilitates rooting, it is injurious to the subsequent development of young plants, which need to evaporate actively in order to be well nourished and to grow rapidly; therefore this means must be used temporarily.

4. Time to Set out Cuttings.

It was formerly thought, in the South, that cuttings soonest planted throve the best, saving in cases of exceptionally humid soil; and indeed, it was thought that the same result could be obtained as is now through stratification, but it was by taking the chances of injury which sometimes results from excessive humidity of the soil during Winter, and the action of frost. It is evidently preferable to stratify the cuttings in sand, and to plant them relatively late, only when the temperature is high enough to insure early vegetation.

Towards the end of March, or the commencement of April, in the Mediterranean region, these conditions seem to be realized best. Besides, the time to be chosen depends, in a certain measure, upon the nature of the soil; light, and warm earth, well exposed, should always be planted before that which is cold and humid.

5. Choice of the Most Suitable Place for Planting the Cuttings.

Cuttings may be set out, either in the open field, in the very place where they are to develop, or in nurseries where they are to take root, and whence they are removed, in the form of rooted plants, then to be put in their permanent places.

A. Planting in the open field.—Planting immediately in the open field presents the following advantages: It avoids the expense of transplanting, and the retardation in the development of the plant resulting from this operation; but it is inconvenient, in that the cuttings are nearly always set out in a locality unfavorable to their rooting. It is better not to use this method, excepting when we have to work in light, fresh, and fertile soils, excepting for varieties easy to root and cheap, such as the *V. Riparia, V. Rupestris*, or *V. Labrusca.*

B. Planting in nurseries.—Planting in nurseries, on the contrary, permits the selection, either through the choice of soil or special care, of conditions most favorable for the rooting of the cuttings and their development. Moreover it lessens the trouble in taking care of them during the first year, as the plants are so much closer together, which admits of cultivation being brought to bear upon the most limited surfaces. It should be employed, almost necessarily, when a vineyard is to be made in clayey land, or in dry, pebbly, or shallow soil, or, in short, when varieties somewhat difficult to root and of a high price are being reproduced, such as the varieties of *V. Æstivalis, Jacquez, Herbemont,* etc.

A nursery for supplying deficiencies should, moreover, always accompany the establishment of a young vineyard.

We shall speak, further on, with regard to plantations, of setting out cuttings in their permanent places; so, laying aside the details of this operation, we shall confine ourselves to saying a few words on the construction of nurseries and the care to be given them.

C. Establishment of nurseries and care of them.—The nursery should be situated, as far as possible, in soil that is light, or of medium consistency, well drained, fresh or irrigable. The soil should be perfectly cleared, mellowed by a tilth of from twelve to fourteen inches, and fertilized with compost quickly assimilable, such as stable manure half decomposed, sheep's or pigeons' dung, oil cakes, or chemical composts suitable for a vineyard.

The planting is done as follows: The cuttings are set upright in little ditches with vertical sides; then a portion of the mellow earth is accumulated and pressed down firmly with the foot against the base of the cutting; then the rest of the ditch is filled up with the remaining earth. The distances generally allowed between the cuttings are not sufficient, and prevent the plants attaining all the development possible during the first year. The most suitable distances seem to be about twenty inches between the rows, and from six to eight inches between the vines.

When the land is not irrigable and not very fresh in itself, it is well to cover the whole surface with straw; the care of the nursery then consists of simple weeding, not deranging the covering any more than possible as long as its protection appears to be needed. When, on the contrary, it is possible to irrigate, the rows are banked up slightly, so as to leave trenches between them through which the water can circulate and thus irrigate by infiltration. Second tilths, frequently repeated, should alternate with irrigation, in order to preserve the effects as well as possible, while maintaining the cleanliness of the soil.

Culture in the nursery may last perhaps for one or two years. Two year old plants are evidently stronger than those of one year, but want of space generally hinders them from acquiring the development that they might have attained in the open field; moreover, the size and length of their roots renders it difficult to take them up; it is found impossible to avoid mutilating them more or less in extricating them from the ground, and they seldom present sufficient superiority over the others to justify the delay and the supplementary care required. It is, therefore, preferable, in most cases, not to keep plants in the nursery longer than one year.

Such are the principal directions now resulting from experiments made on cuttings of American vines. Although, as we said before, this method of reproduction may be considered as the most important one of all those used for the vine, it may nevertheless be advantageously replaced in some cases by layering, which we are now going to consider.

CHAPTER V.

LAYERING.

Layering consists, for the vine, in causing the cane to put forth roots before it is detached from the plant that gave it birth. This process, which, like propagation by cuttings, preserves in the new vine the characteristics peculiar to the mother stock, and even to the cane, offers the advantage over this last of better assuring the rooting of the new plant; moreover, its separation and setting out in place is not effected until it is possessed of all organs necessary for its existence. Therefore, should it be preferred, although its execution may be a little more complicated, for species or varieties difficult to root by cuttings, such as the *Mustang* (*V. Candicans*), *Hermann*, *Norton's Virginia* (*V. Æstivalis*), etc., or for rare or precious varieties, in propagating which we seek to avoid the smallest loss.

We shall examine successively the following points appertaining to layering: 1. Principal methods of layering; 2. Means of facilitating the rooting of layers; 3. The most favorable time for layering.

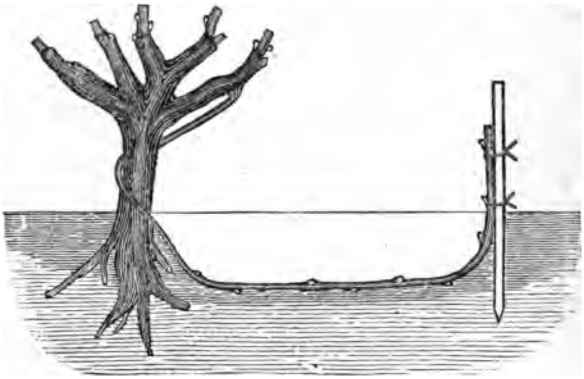
1. Principal Methods of Layering.

The principal methods of layering used are the following: *A.* Simple layering; *B.* Bedding the plant; *C.* Chinese or multiple layering; *D.* Inverse method of layering.

A. *Simple layering* may be employed for the production of rooted plants for replacing on the premises stocks that are lost in a plantation, to free an American cane grafted on a European stock, or for producing rooted internodes destined to serve as subjects for grafting in the workshop. When it is a matter of producing rooted plants, a portion of the cane is simply bedded in the earth as near the mother stock as possible. The extremity of the cane is then raised up so as to have one or two eyes emerging from the ground. All the intermediate buds between the beginning of the cane and the point of its penetration in the soil are cut off, so as to prevent their developing to the detriment of the layer itself. The subterranean passage of the cane should be as short as possible, so as to save the wood, the extremity of which may serve for a cutting; and to avoid the formation of too many tufts of roots, these last developing individually as much less as they are more numerous. Ripened or only herbaceous canes may be layered thus. In the latter case we gain time, since roots are formed in the same year in which a cutting would have had to be ripening. When vines thus rooted are dug up to be transplanted, it is well before planting them to cut them so as to leave only one or two tufts of healthy roots on them, these organs then growing much larger than they would if more had been left.

Simple layering, as we have seen, may also be used to replace a stock that is lost in a plantation, or to free an American cane grafted on a European vine; in these two cases the layer must remain where it has been established. Layering, under such circumstances, is done as follows (Fig. 4): After having found the place of the dead plant, and having carefully dug out its roots, a trench, deep enough for the embedded cane not to be disturbed by tilling (about one foot), is opened between the mother stock and the spot where the new vine is to be installed. A cane of sufficient length is chosen, and, as far as possible, from among those that cannot be utilized for bearing spurs when the vine is pruned; it must be made to penetrate the trench as near the root of the plant as possible, so that it may be protected from accidents that might happen to it during cultivation; then it is bedded at the bottom of the ditch, then raised vertically at the desired point and fastened to a stake driven into the ground; the trench is filled with very mellow earth that is pressed firmly down on the cane. Finally, the emerging part is cut so as to leave only two eyes above ground, and the intermediate buds between the origin of the layer and its point of penetration in the soil, are cut off. Frequently a certain quantity of manure is put, at the outset, into the ditch where the layer lies, in order to favor the development of roots; it seems preferable to manure only the mother stock the first year, and not to fertilize the new plant until after its separation from the parent vine; thus we avoid the invasion of roots from neighboring vines which would otherwise develop greatly in the ditch, and thus mingle unfavorably with those of the cane before the latter are large enough to buffet with them.

FIG. 4.



Simple Layer.

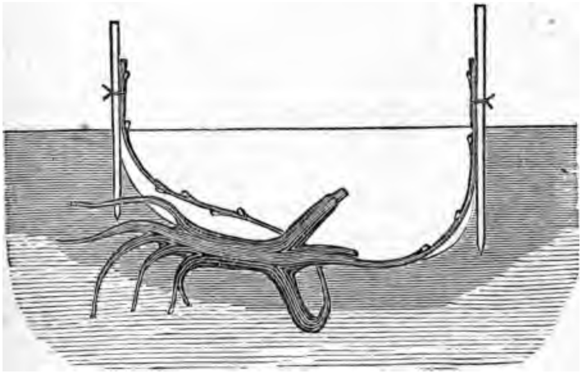
When a cane near the plant to be replaced is not long enough to reach the spot the latter occupied, we may proceed, either by a series of successive beddings, repeated from year to year until our end is attained, or by grafting, with the English cleft, on a branch chosen among those best situated, a cane of suitable length, and then treating it in the usual way. By this last process, the variety may be preserved or changed by using, in lengthening it, a cane of the same or of another variety.

Simple layers, destined to remain in their places, are generally severed from the stock at the end of two years; too early a severance abates vegetation for the time being, which is injurious to fructification. Finally, this mode of layering allows us, by taking up, in the Winter, the canes imbedded since the preceding Spring, and dividing them below each node, to obtain a large number of rooted fragments. Rooted fragments, to which Mr. Champion gave the name of rooted internodes, may be grafted like ordinary cuttings, and perhaps, with somewhat greater chance of success.

B. Layering by Bedding the Plant.—Layering, by bedding the plant, may be destined, either to replace a lost plant, or to free an American graft on a European stock. This system of layering may be considered, in a general way, as inferior to the others; plants resulting from it are usually neither vigorous nor strong, which must be attributed to the feeble development and bad distribution of the roots, partly developed on old wood and too widely dispersed. Moreover it is a more expensive operation than the preceding. There is no reason for using it, excepting when it is desired to obtain, simultaneously, several layers from the same parent stock, in which case it is better than any other process.

This layering is done in the following manner (Fig. 5): A deep ditch is dug, starting from the mother stock and extending to where the new plant is to be installed; the principal roots are taken off the vine until it is sufficiently mobile to be embedded in the bottom of the ditch without being broken or mutilated; then the extremities of two canes are raised above the surface of the ground, one at the point where the new plant is to be, and the other in the very spot where the mother-stock was found. The ditch is then manured well and filled up with well mellowed earth. By means of ditches, properly situated, several canes may be directed towards various points, and thus many vines be obtained through layering one.

Fig. 5.

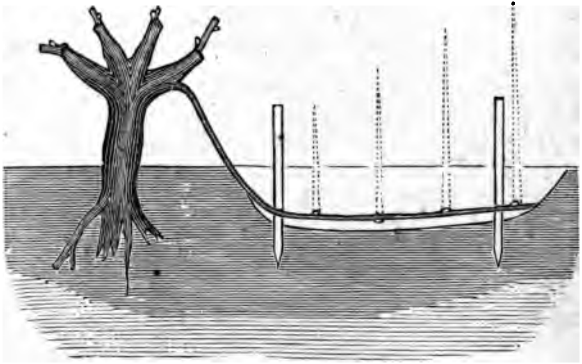


Layering by Burying the Vine.

C. Chinese Layering.—Multiple, or Chinese layering, is for the production of rooted plants. It presents the advantage of rendering it possible to obtain the latter in a single season; that is to say, in as short a time as is generally necessary for the production of a cutting, and that without loss of wood. It is done as follows (Fig. 6): A ditch, about ten inches deep is dug, starting at the mother-stock; a suitable cane is chosen and laid horizontally in this ditch, and kept at two and a half to three inches below the surface of the ground, by means of little stakes to which it is firmly attached. Then all the intermediate eyes between the beginning of the cane and the point where it enters the excavation are cut off. When the vine begins to grow, every bud develops, and as soon as the canes coming from them are six or eight inches long, the ditch is filled with the earth previously dug out, which, if of good quality, is simply manured with decomposed dung, or with a mixture of good made earth, mould, and sand, if passable or poor.

When the soil lacks freshness, it must be covered with straw and irrigated. During the course of Summer, numerous roots develop on the old cane and on the branches coming from it. When the time for planting comes, it is only necessary to take up the layer and divide it into as many parts as there are canes developed on it; each of them constitutes a good rooted vine.

FIG. 6.

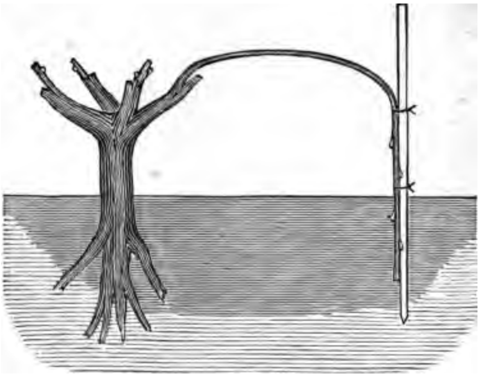


Multiplied, or Chinese Layer.

This method may be considered as the most practical and economical for reproducing species and varieties that root with difficulty, such as the *Mustang*, *Herbemont*, *Norton's Virginia*, and *Hermann*, whenever we work in good and not too dry soil.

D. Inverse Method of Layering. The inverse method of layering may be utilized, either for replacing a lost plant, or for the establishment of an American vine having no foot, by using a cane coming from a vine of this origin, grafted on a European stock. A cane (Fig. 7), of sufficient size, and conveniently situated is directed towards the point where the new plant is to be established; its free extremity is then bent down and forced to a depth of from eight to ten inches in a ditch previously manured. All the intermediate eyes, between the origin of the cane and the point where it meets the ground, saving the two nearest the earth, must be removed. Roots are developed in the course of the year, and the new plant may be separated from the old the following Winter, whatever may be the quality of the soil. Plants produced in this way are generally robust and of good constitution; they frequently yield fruit the same year the operation is performed. In short, this process may be considered as superior to ordinary lay-

FIG. 7.



Layering Inversely.

ering, as a means of replacing stocks as well as for the production of rooted plants in places where they are to remain. The only fault to be found is, that it hinders plowing during the time preceding its separation from the mother stock, and that it entails too great a loss of wood.

2. *Means of Facilitating the Rooting of Layers.*

Although the rooting of vine-layers is almost assured by the sole fact of a healthy cane growing in sufficiently fresh and mellow soil, nevertheless, divers means may be employed for the emission of roots and their development. Such are, for instance, a ligature of iron wire at the middle of the underground part of the layer, a cleft held open by a little peg, a tongue of wood cut out to the center of the cane or simple barking in the same place. The first of these processes induces the formation of woody swellings favorable to the production of root buds; the other, by causing the formation of generative layers of the wood, result in producing round swellings, many of which develop into roots.

Irrigation and covering with straw, or manure not decomposed, which keep the soil in a fresh condition advantageous for good vegetation, also aid greatly in the success of the operation.

3. *The most Favorable Time for Layering.*

The time that appears best suited for layering ripened canes is that almost immediately succeeding the fall of the leaves. The cane is then prepared, by a sort of stratification, to put forth roots quickly, as soon as vegetation begins. However, exception must be made for soil that is very wet in Winter, in which the buds would risk being injured.

When herbaceous canes are used, they should be buried until they are pliable enough to be bent without danger of breaking. In fact, the more tender the tissues are, the more apt they seem for putting forth roots.

On the whole, as can be seen by the preceding, layering is a process of more complicated execution, and generally less economical as regards good utilization of wood, than propagation by cuttings—a fact that justifies the reluctance of viticulturists to substitute it for the latter. Nevertheless it can render great service, thanks to the invariable results it gives, even for varieties most difficult to root; and it deserves by virtue of this to engage seriously the attention of practitioners.

CHAPTER VI.

GRAFTING AMERICAN VINES.

[NOTE.—This chapter, containing only a résumé of the information published previously by Professor Foëx, and translated and published in the first annual report of the State Viticultural Commission of California, is not reproduced here. Reference is hereby made to said report.—TRANSLATOR.]

C. ESTABLISHMENT OF THE VINEYARD.

CHAPTER VII.

PREPARATION OF THE SOIL.

1. *Tilling.*

Soil destined for planting of American vines should be prepared with very great care. In fact, it appears from the several facts we have mentioned regarding the adaptation of divers varieties to the soil, that the obstacle most to be dreaded is excessive humidity in Winter, and the consequent cooling of the soil, on the one hand, and on the other, the too great lack of water during the droughts of Summer. Now, nothing can combat these two inconveniences more efficaciously than deep well effected tilling. In fact, if the excessive quantity of water drains easily into the interstices of the well divided soil, it also remains there a long time under these conditions, because the phenomena of capillary ascension which take it to the surface, where it evaporates, act with less force there than in compact soil. Finally, the roots can penetrate further, and better escape the action of drought in deeply plowed land.

A. Depth of the Tilling.—Previous tilling of the soil, therefore, is nearly always essential, with but very few exceptions. The depth of this operation must necessarily vary according to the nature of the soil where the vineyard is to be. When we have to deal with dry and arid land, it is necessary to descend deeper than in fresh and fertile soil. While in the first case we are obliged to dig a bed two feet deep and over, in the other a depth of one and one third or one and one half feet often suffices; however, when the tillable bed is a thin layer, overlying a permeable subsoil of calcareous gravel, there is no need of touching the latter, in which the vine roots may penetrate and be protected from drought.

Tilling should be particularly deep when, as is often the case with American vineyards, one that has been torn up is to be replanted immediately; it is then necessary, as far as possible, to dig deeper than was done when the preceding plantation was established; we often penetrate, under these conditions, as far down as two and one half or two and two thirds feet.

B. Method of Tilling. Tilling may be effected, either by hand or with a plow. The first is evidently preferable, owing to the perfection it admits of in mellowing the soil; it is the only possible method in certain rocky and hard land, but is infinitely more expensive than the second way. That by the plow can be applied with sufficient efficacy only in yielding and deep soil, unless it is possible to use steam plows, which are able to overcome rather considerable obstacles, and which mellow the soil infinitely better than implements drawn by teams. However, whatever method is used, we find ourselves in presence of one of the three following cases: First, the arable bed is of better quality than the subsoil, and the latter cannot be improved by the action of the air; second, subsoil may be advantageously modified by atmospheric influence; third, the subsoil may improve the arable bed by being mixed with it.

By hand, the work is done as follows: In the first case, some of the workmen lay bare the subsoil, which others dig up, leaving it in its place; in the second, the workmen till so that the beds are left in an inverse order to that they formerly occupied: in the third, the subsoil is mixed with the arable bed.

If, on the contrary, teams are used, we may avoid bringing the subsoil to the surface by following a good ordinary plow, which overturns the arable layer, with a subsoil plow that simply breaks up the soil, leaving it in its former place.

That the ground may be completely broken up by implements, it is best to use, successively, a plow that will give a medium tilling, and a deep plow, Bonnet style. The first breaks up the surface soil, throwing it to the bottom of the furrow made by the deep plow; the second brings up, from the bottom of the furrow made by the ordinary plow, a new strip of earth which it overturns on top of the other. In yielding soil, and when very great depth is not sought for, we may substitute for these implements the Coëtgreave plow, which does the work of both at the same time.

C. When Tilling should be done.—The most favorable time for tilling seems to be the end of Autumn and beginning of Winter, then the earth is not so hard as it is often rendered by the summer droughts. The dull season, beginning then, leaves men and teams at leisure; moreover, the soil dug up at this season can remain in that condition throughout the Winter, under the influence of frost and thaw, and so be thoroughly aired; then, too, it undergoes a primary settling before planting time, which may be injurious if occurring during the first development of the young plants. Everything, therefore, leads to adopting this season in preference to the others.

2. *Fertilizing.*

Unless the soil destined for a vineyard is unusually rich, it should be fertilized before planting. This precaution is especially requisite when an old vineyard is to be replaced; it is then necessary to restore to the soil all materials, azote, phosphoric acid, and potash, that have been previously taken from it by vegetation. American vines, especially those subject to chlorose, are perhaps greedier for these materials than others. When a plantation of these varieties is established in a vineyard recently planted with European vines, and in soil of average fertility, about thirty to thirty-five tons of manure, or their equivalent in chemical fertilizers, must be applied to the acre. In manuring a vineyard we should seek fertilizers of rather slow decomposition, and consequently susceptible of keeping pace with the development of the roots of the plants, and of furnishing to the vines for a long while the elements necessary for their vegetation. Horn, old leather, the residuum of dried glue, reeds, branches of box, rock-rose, and mastic tree, or other analogous materials are advantageously employed in this case. Fertilizers of this nature, moreover, do not induce too active vegetation of the young plants, generally very exuberant in itself.

Fertilizing materials should be distributed very deeply in the plowed soil, without touching the bottom, however, to which the water carries a sufficiency of the soluble elements contained in it.

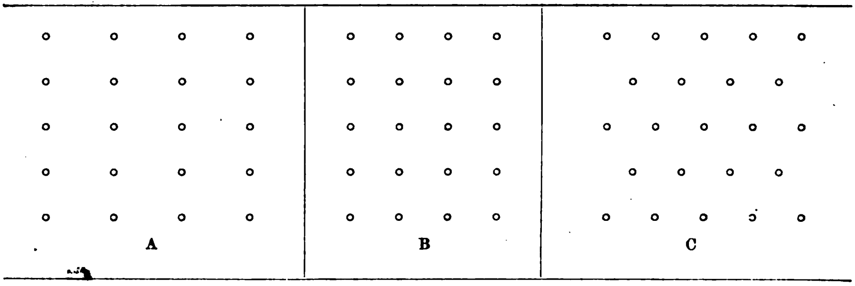
CHAPTER VIII.

PLANTING.

1. Laying out the Vineyard.

A. Arrangement in Planting.—It may be considered as a generally admitted fact that plantations *à plein,* that is to say, completely covering the ground devoted to them, are alone compatible with the present state of our southern viticulture; those of intercalary culture cannot have the intensive character which the former tends more and more to acquire. But the plantation *à plein* is adapted to various arrangements, whose mutual value must be discussed; they are: planting in rows; second, in squares; third, in quincunxes (Fig. 19).

FIG. 19.



A, plantation in lines; B, in squares; C, in quincunx.

In plantation in rows (Fig. 19, A) the vines in the rows are nearer together than the rows themselves. This arrangement is not very favorable to good growth and abundant fructification of the vines; their development is notably diminished when the roots of the neighboring vines come in contact with each other, which, owing to the method in planting, occurs long before they occupy all the space allotted to them. Experiments for which we are indebted to Mr. H. Marès, have proved that the vintage, under these conditions, was twenty per cent. inferior to that which can be obtained from a square plantation, in which every plant occupies the same amount of space. But if this disposition is less advantageous than the others, in this respect, it has the advantage over them in allowing us to plow with teams during the whole period of vegetation, even when the vines are of spreading growth, which entails important economy of hand labor.

Plantation in squares (Fig. 19, B) is preferable to the preceding one, as we have just seen, with respect to production, at least. Moreover, it renders it possible to plow crosswise in two perpendicular directions, with sufficient intervals. Then, when a plant dies, it can be easily replaced by layering a cane chosen from one of the four neighboring vines.

The quincuncial disposition (Fig. 19, C) is that wherein the plants, taken in groups of three, occupy the angles of an equilateral triangle, and, in groups of four, those of a lozenge. It possesses in a high degree the divers advantages that we have found inherent in the square plantation. It admits of plowing crosswise in three directions, and replacing lost stocks by layering a cane that may be chosen among those of the six surrounding plants. Moreover, it incloses in a given surface a greater number of vines than the arrangement in squares while leaving each one an equal space for the development of its roots, whence the augmentation in quantity of the vintage. The only inconvenience arising from this system is, that when varieties of spreading bunches are planted, the canes soon cover the ground, and thereby prevent the use of plows.

On the whole, as may be judged from the preceding, it is best in planting erect varieties to arrange them in quincunxes or squares; when, on the contrary we are dealing with varieties having trailing canes, we must make sure before adopting these systems that we have enough workmen to do the Summer cultivating by hand, and that the extra expense involved in such labor will not exceed the superior value of the vintage over that furnished by plantations in rows.

B. Space to be left Between the Vines.—This question applies only to vines cultivated for their fruit, since grafting-stocks once grafted upon must be treated like the old varieties they have to nourish. As to the former, they should be planted further apart than our European varieties, owing to the greater vigor of their vegetation, and their generally very spreading growth; but an augment of one sixth in the space left between the vines in all directions may be considered as sufficient. (For example, about six feet, in place of five feet.)

C. Outline on the Ground.—The position of the vines is indicated by the intersection of lines marked at convenient distances by means of chalk lines or furrows on the ground, which has been previously mellowed with a harrow.

2. *Grouping Varieties.*

The system of planting different varieties in separate groups is now almost generally admitted, and must be considered infinitely preferable to mixing the varieties. In this way there is greater regularity in vineyards, wherein the vines are obviously of the same vigor, and where, consequently, one cannot exist to the detriment of the other; then, too, the fruit ripens more uniformly; moreover, all the vines have the same appearance and, consequently, may be subjected to the same methods of cultivation.

3. *Planting.*

Planting is done in different ways, according to whether we deal with cuttings or rooted plants. In the first case, an iron rod is used, either a simple cylindrical bar of from one and one fifth to one and three fifths inches in diameter, pointed on the end, or a quadrilateral rod about four fifths of an inch wide on each side, surmounted by a perpendicular wooden handle, like that on a carpenter's auger. The rod is inserted vertically into the ground, then carefully withdrawn, so that the hole thus made remains open; the cutting is then put down in the hole as far as desired and made firm by the earth being pressed around it so that there is as close contact as possible. If the work has been well done, the cutting should be held in place so firmly that it cannot be pulled up easily. It is then topped at two or three eyes above the ground, according as to whether the stock of the plant should be of greater or less height.

In the case of pebbly or insufficiently mellowed earth, it is well to fill in a certain quantity of sand and vegetable mould around the cutting before closing the hole; we thus prevent contact with the air and consequent drying of the cutting, and assure a most favorable spot for the development of the young roots.

When setting out rooted plants, first an iron dibble is inserted at the place marked for the plant, then a little hole one foot wide on each side is dug in such a way that one of its sides comes close to the dibble; the latter is then withdrawn, which leaves a hole just where the new vine is to be placed.

Plants should be taken up carefully from the nursery, preserving as many roots as possible; these organs may be considered as storehouses abundantly supplied with materials necessary for the first development of the plant, and which it is consequently important to be saving of; they should simply be freshened, that is, only the dead extremities, or those irregularly cut should be removed. The vines are then set out as previously directed; the roots are properly spread out in the hole, which is then partly filled in with mellow earth, pressed down slightly; the filling in is then completed, by simply putting back into the hole the earth that was dug out, but not pressing it down.

When speaking of propagation by cuttings, we gave the season that is apparently most favorable for setting out cuttings. As for rooted vines, unless they have to be put in cold humid soil, it is well to plant them before the end of Winter, so that the earth used in filling the holes may settle before the vegetation begins.

4. *Care of Young Plantations.*

Young plantations, during the Summer following their establishment, should be frequently tilled, in order to keep them perfectly clear, and also to preserve the freshness of the soil, indispensable to rooting and good development. This tilling, which may be done advantageously with hoes and scarifiers, should be finished off with digging by hand around the roots of the vines. In doing this work, the young vines, beginning to take root, must not be loosened. In order to protect them, a little stake is sometimes driven in the ground by each vine, or at least, by those at the end of the rows, which are more likely to be run against by the animals when turning around. At other times, the cutting has four or five internodes above the ground, all the eyes excepting the two lower ones being cut off; they are thus more easily seen, and not so likely to be touched.

The following Winter the vines are bared to clear them of suckers that have developed on them. Dead stocks, or those of poor vegetation, are replaced with rooted vines that were raised in the nursery for this purpose. Then the vines are pruned, which must be done late, owing to the propensity of the young plants to put forth shoots early; if the top eye has developed vigorously, the shoot produced by it is cut off at the second or third eye, and the shoots coming from the lower buds removed; if, on the contrary, the top eye has proved abortive, or developed poorly, the better shoot developed below is used to supply the prolongation necessary for the desired height of the vine. In pruning young vines, quite a number of eyes must be left, in order that they may put forth a great many shoots; none of them can then attain great length, and thus they better escape the action of heavy winds, which often cut off their extremities in Spring. Finally, the stocks are banked up with earth, or fastened to stakes, to prevent, as well as possible, their being broken by the wind.

Care of the vineyard during the years following, up to the beginning of regular cultivation, is obviously the same as that we have just described, with simply the difference that may arise from the greater rusticity slowly acquired by the young plantation.

D. CULTIVATION.

CHAPTER IX.

Cultivation of the vineyard consists of: First, pruning; second, removing the soil from the foot of the vine; third, fertilizing and improving the soil; fourth, tilling. We shall examine the way in which each of them may be practiced in the South, giving the peculiarities that may be entailed in their application to American vines.

1. *Pruning.*

Pruning has so considerable an influence on production, that all concerning it deserves to be examined with the greatest care. We shall consider it successively as to the following points, which take up its most important elements: *A.* Production of fructiferous canes. *B.* Form of the vines. *C.* Height that must be allowed the vines. *D.* When to prune.

A. Production of Fructiferous Canes.—The vine bears its fruit on shoots of the current year, produced by the development of eyes or buds on the preceding year's canes. Therefore, every year, when pruning, one or more of the latter must be saved, their length being reduced, but a more or less considerable number of buds left on them. When the canes are pruned to from one to three buds, the pruning is said to be short, and the portion of the cane that is left is called a spur; if, on the contrary, a greater number of eyes are left on the preceding year's canes, the pruning is long, or of long wood.

Generally the choice of one or the other of these systems is not arbitrary; it depends upon the special aptitudes of the varieties to which it is to be applied. In fact, some have their fructiferous buds near the base of the preceding year's canes, and consequently only the lower part of them need be preserved; others bear fruit on canes coming from eyes on the extremities, so that they must be pruned long; finally, some put forth fructiferous canes at every bud. In the last case, either system of pruning may be chosen. However, whenever long pruning is possible, the vintage will be larger than in the case of short pruning.

Most of our old southern varieties admit of only short pruning, and their being grafted on American stock cannot, in any way, modify the system adopted for them up to the present time; but it is different with the *Æstivalis*, that are cultivated for the sake of their fruit; nearly all of the latter, the *Herbemont*, *Cunningham*, *Black July*, etc., seem to require long pruning. As for the *Jacquez*, it possesses, without doubt, the property of yielding fructiferous canes by the evolution of its eyes, even the lowest, but it is very well adapted for long pruning, and gives infinitely more fruit[1] by this method, which will probably be applied to it in most cases.

The conditions under which the divers systems of pruning should be applied, being thus pointed out, we shall now study the points relative to their execution, commencing with short pruning. The first element to be considered is the choice of the cane that is to furnish the spur. As regards production of fruit, a cane of average vigor, very healthy, and well ripened, should be preferred; those of too great development give more wood than fruit, while the small ones do not furnish sufficient vegetation. Moreover, in order to assure good shape of the vine, it is necessary to choose, for short pruning, a cane so directed as to assure a suitable prolongation of the old wood or arm that bears it. Therefore, in vines trained *en gobelet*, a cane radiating from the center towards the exterior, oblique, and more or less ascending, according to the natural appearance of the variety under consideration, must be selected. A more vertical cane must be selected for varieties whose canes tend to spread too far apart, and a more horizontal one in the case of erect varieties which are of too close a growth. In order to avoid too rapid elongation of the arms, the spur must be as near as possible to the one of the preceding pruning.

The cane once chosen, all the others are taken off, and it is then cut down to the desired length, which is generally to two eyes, besides the eye at the base (*bourillon*). Sometimes it is well to leave a third eye in vines exposed to the action of frost by the precocious bursting of their buds, or by their situation. The *bourillon* generally remains dormant under these conditions, and may develop in case of accident, yielding some fruit, or at least excellent canes for fresh supplies. If the internode is not too long, the cane should be cut at the node, just above the last bud that is kept, and quite perpendicularly to its axis; there is thus a woody partition to work on (Fig. 23), which forms a diaphragm at this point, and prevents water from penetrating the pith and rotting it. When, on the contrary, the nodes are far apart, the cane is cut obliquely, at a short distance above the last eye that is to be kept; the inclination of the cut facilitates the shedding of water and lessens the chances of decay. Directions for long pruning are sensibly the same as those we have just given for the formation of spurs; but a long cane having to nourish more shoots than the latter, as a general thing none of them can develop sufficiently for fresh supplies the following year, therefore this system should not be used alone, but must be completed, as Dr. Guyot has suggested, by the addition of a spur, which furnishes more vigorous and more suitable canes for pruning.

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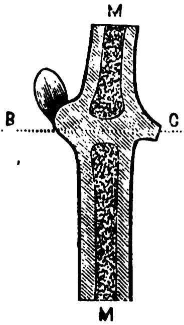
[1] In experiments made in 1880, in the School of Agriculture at Montpellier, vines of the *Jacquez* pruned long (Fig. 25) yielded about seventeen pounds of grapes, and those subjected to short pruning yielded only about twelve pounds.

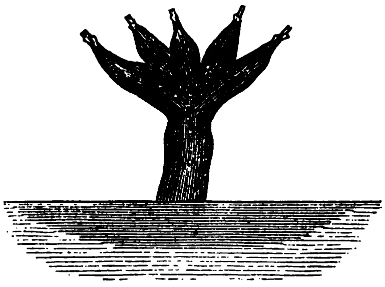
FIG. 23.



Section of a joint of a cane. The line B C shows the cross section of the woody structure; M, pith.

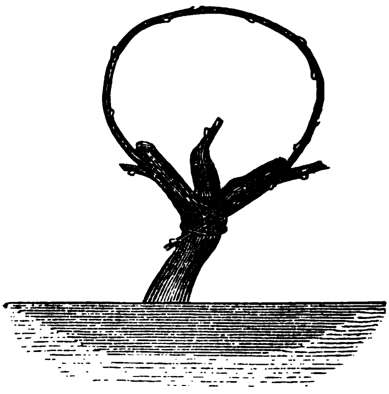
B. Shape of the Vine.—Vines made to assume some regular form are trained *en gobelet*, *en espalier*, or *en cordon*. In the form *en gobelet*, a foot, more or less, high, supports a certain number of arms, which, diverging, form a sort of vase in the center (Fig. 24). This system is the most general one in the south of France; in fact, in this locality, it is advantageous in assuring an equal distribution of canes over the whole surrounding ground, and consequently in preventing the latter, to a certain extent, from becoming too dry. It is well adapted for cross plowing and layering; then, too, what is better than all, no props are needed, and the grapes are screened from the direct rays of the sun, which is likely to burn them or diminish their size.

FIG. 24.



Vine low pruned, Goblet Style; pruned with Spurs.

FIG. 25.

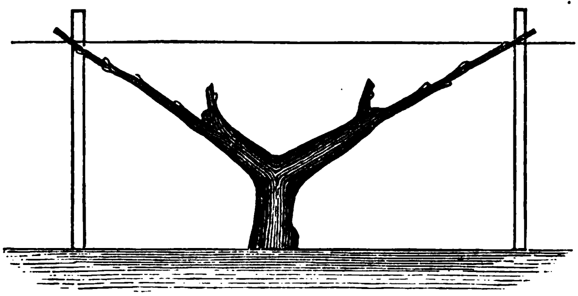


Vine, Goblet Style; a long fruit cane preserved in circle.

The number of arms to be left on the stock varies according to its vigor. It should be greater when unproductive buds are developed on the old wood. On the other hand, it should be less when there is found to be too great diminution in the length of the shoots, notwithstanding the usual care and manuring. This form is generally associated with short pruning; however, besides the spurs, there may be left on one or more arms, a long shoot, which is curved like a hoop over the vine, and held in place by being interlaced with another, or fastened with an osier to an opposite arm (Fig. 25). It is simply necessary to see that the long canes are produced successively on different arms every year, on account of the great development they induce in the latter. This process has yielded satisfactory results in experiments made in the Agricultural School of Montpellier on the divers varieties of *V. Æstivalis* cultivated for their fruit, such as the *Jacquez, Black-July*, and *Herbemont*, and we believe it is positively the best one to adopt for those varieties in countries where vines are usually pruned *en gobelet*, and where props are not used. The fruit does not drag on the ground, the canes producing it being supported at the same height as the others, and the shoots being distributed the same as in short pruning. As for European varieties grafted on American stock, as we have already had occasion to say, we do not think that there is any need of modifying for them the methods that have long been used.

In the form *en espalier*, the arms are symmetrically distributed (Fig. 26). It is adapted to localities where the grape, in order to ripen, must be exposed to the action of the solar rays. The only inconvenience is in its requiring somewhat minute care for an equal degree of development to be maintained in its divers corresponding parts. Under conditions suitable for it, the cordon, which is easier trained should be preferred to the latter. This form is characterized by the vine following a single direction, horizontal, vertical, or oblique. It is formed by one cane bearing without the help of arms, spurs, or both long shoots and spurs (Fig. 27). Under such conditions there is no need of attending to the equilibrium of the various organs of the vine, since the growth is always in the same direction.

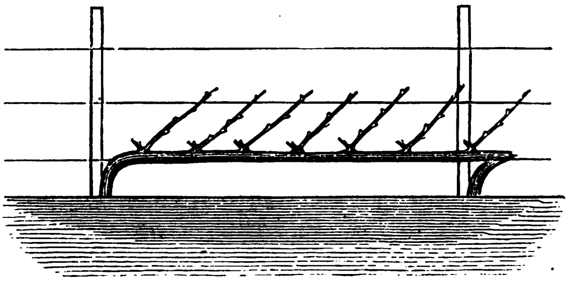
FIG. 26.



Vine staked, *en espalier*, with long wood and spurs.

Training the vine *en chaintre*, which is done in Touraine, is an application of pruning *en espalier;* the vines, very far apart, consist of a symmetrical branch of the old wood extended horizontally, and supported by little forked pieces of wood driven into the ground, and furnished with long cuttings (Fig. 28). This system seems to be well adapted to the peculiarities of the American *V. Æstivalis;* if applied to grafting stocks, it would be advantageous in lessening the amount of grafting to be done, and, in every case, the number of vines to be planted to the hectare, owing to the considerable distances that it admits of

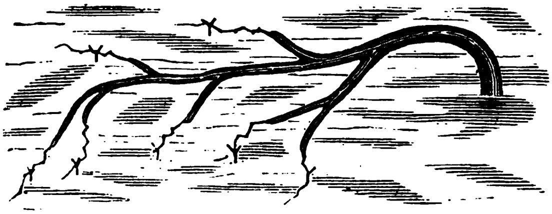
FIG. 27.



Cazenave's System of Cordon, with Long Wood and Spur.

leaving between the stocks. Unhappily it is inconvenient in the warm and dry region of the south, as the vine has to be disturbed during Summer cultivation, which often causes the grape to be sun-burnt. When this danger is not to be feared, it is preferable to substitute for the *chaintre en espalier*, which is most often used, a *chaintre en cordon*, which is easier trained.[1]

Fig. 28.



Vine Trailed upon the Ground—Chaintre System.

C. Proper Height of the Vine. Vines may be classed, as regards the development they are allowed to acquire, in three groups: low vines, those of average height, and high vines.

Low vines, as their name indicates, are those that put forth their canes near the ground, and consequently the fruit is found quite low, at about ten inches, or even less. They yield the sweetest grapes; owing to their proximity to the soil they are, in fact, subjected very directly to the effects of reverberation and radiation, that are produced there as on a trellis work, and which facilitate maturation. But the action of radiation, which is manifested in Summer, by an emission of the heat absorbed in excess by the earth during the day, to the benefit of neighboring objects is lost on the other hand, in Spring, by a lowering of the temperature of the ground and adjacent objects, which may reach thirty-two degrees, and even lower. This lowering results from the heat passing, in calm nights, from the ground towards celestial space. Low vines must therefore be more exposed than others to the influence of hoar frost, and hence can be cultivated only in warm climates or on hill-sides, where these influences are less to be feared; but it should be done unhesitatingly whenever possible, owing to the superior quality of the fruit that may be obtained in this way. High and average vines, on the contrary, in which the canes are allowed to attain a height sufficient for them to be protected from the action of nocturnal radiation, yield must not rich in sugar, and vines should not be cultivated thus when it is avoidable. Moreover, there is seldom any necessity of resorting to these last methods in the South; but, when it is necessary to do so, the *Jacquez* seems to be one of the varieties best adapted to them, on account of the naturally very great alcoholic richness of the wine it produces.

D. When to Prune.—Vines may be pruned during repose of the vegetation, from the time the canes are sufficiently ripened until the vines begin to weep (*pleurer*). However, it is best to avoid doing it during this period when the cold is intense: the wood is then more brittle, and the tissues, newly cut, are in danger of being injured by the frost. Pruning should not be done until late in regions, also, where hoar frost is to be feared, and when we have to deal with varieties whose buds burst early, in order to retard the beginning of vegetation. The quantity of material, that would have induced the development of a small number of buds, after pruning, is thus distributed to a large number, and consequently has less influence over each in particular. But as long as the canes are not removed, there can be no tilling done, and it is likely to be put off beyond the desired time; therefore, it is generally best to cut off all canes that are not to yield spurs, then to prune the others, provisionally, at a length of from twelve to sixteen inches, and, later, to cut them down to the desired length.

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[1] See *Culture de la Vigne en chaintres*, by A. Vias, instituteur, Paris, Librairie Agricole de la Maison rustic, 26 rue Jacob.

2. *Removing the Earth from the Foot of Vines.*

The earth is removed from around the vine in order that the foot may be cultivated perfectly. By this means, the weeds that escaped during ordinary plowing may be gotten rid of, and the larvæ of insects, which are often hidden under the old bark at the junction of the root with the stock, are killed by the cold; moreover, it facilitates the destruction of suckers and superfluous roots, which, especially in the case of grafts, may have an unfavorable influence on the future welfare of the vine; it is often done preparative to manuring.

This work may be effected, either by means of conical holes or continuous trenches along the rows of vines. In the first case, it is done by hand, the excavations being from six to eight inches deep, and of such a diameter that they touch each other. Under these conditions, it is estimated that the operation is equivalent to a complete cultivation of the surface of half the ground. In the second case the work is contemporaneous with the first cultivation, and may be effected either by hand or with the plow. When the last method is used, plows called *vigneronnes d'echausseuses* are employed, and the little strips of earth remaining at the roots are removed with a hoe.

3. *Fertilizers and Improvements.*

A. Fertilizers.—The vine requires at the same time nitrogen, phosphate of lime, and potash; the first two seem to give the plant a powerful and vigorous vegetation, and the third appears to favor the production of sugar in the fruit.[1] All fertilizers containing these three elements in suitable proportions, and sufficiently assimilated, may, therefore, be advantageously applied.

Ordinarily, for fertilizing vineyards in the South, stable manure, sheep's manure, fecal matter, woolen rags, horn, old leather, oil-cakes, residuum of grapes, reed-canes, seaweed, branches of divers wild plants, such as box, rock-rose, etc., and soot, are used; moreover, divers chemical composts may be used with advantage.

Stable manure contains from four to five tenths per cent. of nitrogen, from seven to eight tenths of phosphoric acid, and about four or five tenths of potash. From twenty-two to thirty-three tons are applied to the hectare (two acres, one rood, thirty-five perches) every four years; in a rather fresh state, in impermeable, clayey land, and more or less decomposed in soil that is light or of average consistency, and especially where calcareous.

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[1] See C. Saint Pierre; *Nouvelle série d'expériences pour l'Etude des engrais chimiques appliqués à la culture de la vigne. Messager Agricole,* March, 1873.

Sheep's manure contains .72 per cent. of nitrogen, one and fifty-two one hundredths per cent. of phosphoric acid. As far as known it is richer than stable manure; its effect on vegetation, also, is more apparent and of shorter duration; a dose of about twelve tons is used every three years.

Fecal matter, the composition of which is quite variable, is not valued as a fertilizer for vines on account of its too energetic action on vegetation, which causes the production of watery must, and wines wanting in solidity. Its influence does not last more than a year. These inconveniences may be palliated, and a more advantageous result be obtained, by mixing the fecal matter with vegetable debris (water tan, sawdust, peat, seaweed, etc.).

Woolen rags, containing from ten to fifteen per cent. of nitrogen and quite a large proportion of phosphoric acid, are highly valued by southern viticulturists, especially for dry lands, where they preserve a freshness favorable to the vines. From one to two tons is used to the hectare, and the effect lasts for four or five years.

Horn (fourteen and eighty-six hundredths per cent. of nitrogen and forty-six and fourteen hundredths per cent. of phosphate of lime and magnesia) acts still more slowly than rags. It is the same with old leather, which, for this reason, must be decomposed before being used, in composts of lime, or fermented in manure.

Cakes of oil seeds contain especially nitrogen and phosphate of lime. The most used are those made from:[1]

	Nitrogen, per cent.	Phosphoric Acid, per cent.
European rape seed	4.92	2.83
Exotic rape seed (variegated rape of Bombay)	5.53	1.98
Mustard seed	5.15	1.67
Wild mustard seed	4.46	1.83
Indian poppy seed	5.81	2.88
Ravison	4.99	1.02
Castor bean, crude	3.67	1.62
Castor bean, pulp	7.42	2.26
Black sesame	6.34	2.03
White sesame	5.81	2.07
Variegated sesame	5.51	1.94

They are used in doses of about two tons to the hectare. Usually they are entirely absorbed the following year after they are used. Owing to the small quantity of potash contained in them, it is well to apply to the vines simultaneously from eight hundred and eighty to one thousand one hundred pounds of chloride of potassium, sulphide of potassium, or sulphate of potash. This addition is also useful when rags, horn, etc., are used.

Residuum of grapes contains one and seventy-one one hundredths per cent. of nitrogen, and about five tenths per cent. of potash. Owing to its acidity, it should be used either in calcareous soil or after having been mixed with powdered lime, which neutralizes it, or with ashes, which augments its richness in phosphates.

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[1] These figures are taken from Mr. Décugis' excellent work on *Tourteaux des Grines Oléagineuses,* 1876.—Toulon, chez l'auteur, place d'Armes.

Reeds, seaweed, branches of box, rock rose, mastic tree, etc., may be applied in heavy soil, after having been coarsely chopped, or in lighter soil after being previously decomposed. These divers fertilizers contain nitrogen in the following quantities: Box, one and seventeen one hundredths per cent.; reeds, forty-three hundredths per cent.; seaweed, from forty to fifty-five hundredths per cent.

Soot contains one and fifteen one hundredths per cent. of nitrogen, and a rather large proportion of phosphate of lime and salts of potash; therefore it produces very remarkable effects on the vine, especially in calcareous soil. Two or three tons are used to the hectare. Its action is annual, or nearly so.

Divers chemical composts, containing nitrogen, phosphoric acid, or potash, may be used, either as complements to other incomplete composts, or mixed together in suitable proportions to satisfy in themselves all requirements of the vine. In this last case, the following formula may be used, for which we are indebted to Mr. George Ville, and which has yielded good results:

Superphosphate of lime—pounds to the hectare	1,323
Nitrate of potash—pounds to the hectare	441
Nitrate of soda—pounds to the hectare	221
Sulphate of lime—pounds to the hectare	662

Furthermore, we may use advantageously a mixture of:

Sulphate of ammonia—pounds to the hectare	662
Alkaline salts of Berre—pounds to the hectare	882
Superphosphate of lime—pounds to the hectare	1,103

In addition to these, many other compositions of this nature are possible, according as it is easier or cheaper to procure such and such product containing one of the elements sought for. For example, nitrogen may be found in the sulphates and nitrates of ammonia, and in nitrates of potash or soda; phosphoric acid, in ordinary mineral phosphates, bones, animal charcoal, and superphosphates; then, potash, in alkaline or sulphatic salts of Berre, sulphate of potash, chloride of potassium, sulphide of potassium, and the divers carbonates of potash (salts of beet roots, suint potash).

Although, as we have just said, we are generally guided by the price of the desired element, in the divers forms just given, nevertheless many of them act better than others on the vine, or in certain conditions of the soil. Chloride and sulphide of potassium, and nitrate of potash, for instance, seem to yield better results than the other salts of potash, and, in order to introduce phosphoric acid in calcareous soil, only superphosphates should be used, neutral phosphates not producing sensible effects in such land. Chemical composts are generally absorbed the first year. It is well to use farmyard manure alternately with the latter.

B. Improvements.—The improvements that are generally needed for a vineyard are, in soil lacking limestone, lime and chalk, and in heavy soil *écobuage*, sometimes iron scales, and other similar waste materials.

Lime and chalk not only help to modify the physical properties of the soil, but they seem to improve the qualities of the wine as regards body and color. Ecobuage, according to experiments made by Mr. Pagezy, would augment the vintage and the amount of sugar in the must. Scales of iron generally contain pyrites of iron, which, by oxidation, are transformed into sulphate of iron, a salt that, in certain cases, acts advantageously on vegetation.

C. *When to Fertilize.*—The time that seems most suitable for fertilizing and improving is nearly always the end of Winter (January or February). The most active fertilizers should be used last. Buried in the soil too soon, a large part of the soluble matter contained in them is entirely wasted before the vines begin to grow; too late, they risk not having the humidity that is necessary for these elements to take effect.

D. Distribution of Fertilizers.—Fertilizers are distributed in the vineyard in three different ways: First, in the little conical holes used in removing the earth from the foot of the vines; second, in trenches dug between the rows; third, over the whole surface of the field.

The first method is inconvenient in that it accumulates the fertilizer where it has the least chance of being absorbed; it is especially near the outer limits of the space occupied by each vine, that there are the greatest number of young roots which induce the most active assimilation. By the second method doubtless a portion of the region rich in young roots is penetrated, but in digging the trench the rootlets are destroyed, which occurs every time the work is repeated. Spreading the fertilizing matter all over the ground, on the contrary, has the advantage of carrying it wherever a root can be found; moreover, it is then buried with the plow in the layer of soil overlying the roots, which are not touched, and to which it is soon carried by the water. Moreover, experience has proved the superiority of this last method.

4. Tilling.[1]

Vineyards generally receive three successive cultivations during the year. The first is destined to mellow the ground and subject it to atmospheric influences, the other two are given to keep it fresh and free from weeds.

A. First Cultivation.—The first cultivation should be deeper than those following; it should be deeper as the soil is dryer, in order to insure absorption of a greater quantity of water and to diminish evaporation. In land naturally fresh, on the contrary, where the beard of roots, put forth every year close to the vine, persists during the Summer, we may be stopped by the fear of destroying the rootlets constituting it, which seem to play an important part in the nutrition of the plant. Usually, in the South, the first cultivation penetrates as far as six or even eight inches, in soil that has not the characteristics just given. This work may be done either by hand or with a plow. In the first place, it is generally done by the method *en selette.* The workman, in digging, follows the diagonals of squares, and piles up the earth forming a ridge in the space between, and in baring the vines, he avoids breaking the clods of earth adhering to the roots; thus the surface to be acted upon by atmospheric agents, is augmented. This operation naturally does away with the preparatory removal of earth from the foot of the vines, which we have spoken of before. When it is necessary to use implements with horses, plows called *d'echausseuses* are used, which allow a very close approach to the foot of the vine without there being any danger of touching the arms or spurs; the open furrow is left along the rows of vines which are thus laid bare. The little strips of earth remaining on the roots are dug down by hand. The Araire is often used for this work in the South, but this implement which tears up the ground instead of overturning it, must be considered as very inferior to the plow for this work.

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[1] See Mr. H. Maré's fine article on *Viticulture Mèridionale,* in the *Livre de la Farme,* volume three, Masson, boulevard Saint Fermain 120, Paris.

This first cultivation is usually given in February; it would be dangerous to delay its execution too long in soil that is low and exposed to hoar frost, the ground, when freshly dug up, being more conducive to the formation of frost; but it must not be done too early, as there is danger of the soil being covered with weeds before the hoar frost comes, which is equally to be feared.

D. Second Cultivation. The second cultivation is to destroy the weeds that have developed during the Spring, to fill up the furrows left open in the first cultivation, and to mellow the surface of the ground, so that it will not become too dry. It may be given by hand, but is usually done with teams; in that case, a small, ordinary plow, a small *bisoc*, or, better still, a vine scarifier is used. This last implement is preferable to the various plows, as it does not leave the plowed land too uneven, which would favor drying, and because it allows quicker and more economical work.

This work is generally done in May; it must not be done at the time of florescence, as it might cause the flowers to drop off.

C. Third Cultivation. The third cultivation is, properly speaking, only a shallow second cultivation; it must be done by hand whenever we have to deal with varieties having spreading branches (*Aramon, Jacquez, Herbemont,* etc.,) and when the latter are planted in square or quincunxes; their canes then cover the ground so that implements could not pass between them without doing considerable damage. In other cases the different vineyard hoes, according to the special nature of the soil, are used; or yet, in yielding ground, the *raclette,* which may be attached to an ordinary *araire.*

This work is usually done from about June fifteenth to July fifteenth; during its progress, care must be taken not to touch or lay bare the grapes, for fear of their being sunburnt.

The number of cultivations we have just given is not absolute, but should be considered rather as the minimum. It is generally well to increase the number of Summer cultivations, and it would nearly always be advantageous to repeat them every month from May until the beginning of July.

CHAPTER X.

ACCIDENTS.—ANIMAL AND VEGETABLE PARASITES.—DISEASES.

The vine is exposed, during vegetation, to a multitude of accidents, resulting from the action of divers meteorological phenomena, or from the attacks of animal or vegetable parasites, and to certain diseases which do more or less injury to the vintage, and sometimes even cause the death of the vine. Without attempting a complete treatment of all concerning this important subject, we shall confine ourselves to what is most essential regarding these inconveniences, giving, as far as they are known, the means, either for preventing them or for remedying their effects.

1. *Accidents Resulting from Inclemencies.*

The principal phenomena of this nature that can injure the vine are frost and hail, to which may be added the various influences that often cause coulure and sunburn; then, too, humidity, which causes rotting.

A. Frost.—Winter frosts are rarely to be feared in our European climate; however, in exceptionally cold years, they sometimes occasion loss of the spurs, or even of the whole external part, of vines situated in very unfavorable conditions. In this case, it has often been suggested to cut the vines right down, but the new plant will not yield fruit for several years; it is better to graft the injured vines immediately, they will then bear the following year.

The Spring frosts are most to be feared in the South, owing to their frequency, and because they attack the vine when it is beginning to grow, and when it is consequently most easily affected by them. These frosts may come in the form of ice or hoar frost. The first are caused by a general lowering of the temperature of the atmosphere; they usually occur towards the end of March and the first of April; they either destroy the young canes just appearing, or arrest the beginning of vegetation (circulation of sap), which is accompanied by various injuries to development and vintage. No practical means of preventing these accidents is known; when a vineyard is thus injured, the only way is to cultivate it very carefully, notwithstanding the loss occasioned in the vintage, in order to remedy the injuries to a certain degree.

Hoar frost is caused by the ground becoming chilled, resulting from the radiation that takes place from the surface of the earth towards celestial space; the young vine shoots which are nearest to it participate in this lowering of temperature, and are destroyed when brought to thirty-two degrees, or lower; low and somewhat humid places are most exposed to the action of this phenomenon, and it is most to be feared in April, or the beginning of May, and at about four or five o'clock in the morning. It may be guarded against, either by having high, or averaged size vines in place of low ones, or by means of artificial clouds which form a shelter and check radiation. These clouds are obtained by burning brushwood in the vineyard, substances yielding a fuliginous flame, such as heavy oils, coal tar, or simply manure and weeds.

B. Hail.—When hail strikes young canes still in a herbaceous state, it causes disorganization of the tissues near the parts that are struck, and in consequence almost completely arrests their development; the best way, then, is to prune short above two eyes, as would have been done the next Winter, the canes ripen sufficiently, and sometimes, in good soil, even yield a small vintage. When hail storms occur in the middle of Summer the effect on the canes is less important, but generally a portion of the vintage is lost, without there are means of preventing or remedying this accident.

C. Coulure.—Coulure is the dropping off of the flowers before their fruit is formed. This is sometimes the result of an abnormal conformation of the flower; in that case it is prevented by a suitable selection of the canes that are to serve as cuttings or grafts. But it is generally the effect of diverse atmospheric circumstances, such as a sensible lowering of temperature, prolonged humidity, alternations of dew, and exposure to the hot sun or drying winds during florescence.

Pinching and annular incision, which are of real efficacy, but of difficult application in extensive vineyards, and often dangerous in the southern climate, are suggested as preventives of coulure. Early applications of sulphur given, one several days before the flowers open (the last fortnight in May), another towards the middle of June, appear to be the most efficacious and practical means of preventing coulure.

D. Sun-burn.—Sun-burn which is manifested by the grapes being blighted and their development checked, is nearly always the result of the crushing they have undergone during Summer cultivation, or from quick transition from moisture and shade to burning heat. The only way of preventing it is to use the precautions given in regard to Summer cultivation.

E. Rotting.—Grapes of varieties having watery berries and thin skin, sometimes rot when situated in low land, and when the autumn season is wet. The best means of preventing this danger are, draining the soil and allowing the vine a high stock. When these precautions do not answer, several days before vintage time, a certain quantity of the leaves are stripped off so as to facilitate the circulation of the air. This work is done in dull weather, and not the leaves directly interposed between the sun and grapes, but rather those beneath are taken off. The fruit is thus subjected to the action of atmospheric currents; moreover, it is heated better under the influence of the radiation and reverberation of the soil, which facilitates its maturation, generally very imperfect in places where rotting is to be feared.

2. *Animal Parasites.*

The animal parasites that attack the vine are very numerous, but we shall limit ourselves to giving those most widely spread and most dangerous in the South, telling the means used for destroying them. Excepting the small white snail, they all belong to the insect class; the principal ones of the latter are the Attelabe, Altise, and Gribouri, of order Coleoptera, and the Pyrale, Cochylis, and Noctuelle of order Lepidoptera.

A. Snails.—These mollusks, in mild and humid springs, attack the young vine-leaves just as they are bursting from the bud, or the tender young canes. They leave scars, sometimes quite deep and long, on the latter, that sensibly injure their future development. They are gotten rid of either by picking them off by hand or by knocking them with a little stick into a wide-mouthed funnel (Fig. 29), the lower opening of which communicates with a sack, and which is hollowed out so that it can be put under the vine without being hindered by the stock.

B. Attelabe (*Rynchites Betuli*).—The attelabe is a yellow green beetle, having a sort of lengthened proboscis with which it pecks the leaf-stalks, the leaves then withering and curling up. Mr. Valéry-Mayet, Professor in the National School of Agriculture at Montpellier, from whom we obtained the greater part of the entomological information that will follow,[1] speaks thus regarding this insect:

It sometimes makes great ravages. I have seen, not far from here, in the vicinity of Mèze, vines completely stripped of their leaves, for a mile or two. When only a fourth or a third of the leaves are curled up and dried, the evil is not great; but when all are gone, the health of the plant suffers. You know that the leaf is the respiratory organ in the vegetable. Now, the respiratory organ is never removed without doing harm. The leaves shoot out again to a certain extent, it is true; but the fruit has suffered, its development been checked, and it is in great danger of drying up instead of swelling out. The rynchites lay on each leaf, curled up like a cigar, from one to seven or eight eggs. The larva coming from them eats the leaves, and has attained its full growth at the end of fifteen days. It then falls to the ground, where it buries itself at a depth of eight or twelve inches. There it makes an oval cell, where, about September only, it is transformed to a pupa. The perfect insect is hatched in October, and, if the season is exceptionally fine, it is seen on the vine leaves, where the first cold will very often find and kill it. This is the best thing that can happen for the owner of the vineyard. It is well to pick off the curled leaves in June; but not only is it necessary not to begin too late, and so pick off cigars no longer containing larvæ, but even then nothing is equal to the inclemencies of the weather for destroying insects. The Rynchites betuleti is called *Lùsette* in northern and central France, and this name is often applied to all weevils that are enemies to agriculture.

C. Altise (*Altica Ampelophaga*).—The altise is a small green or bluish beetle, not quite one fifth of an inch long, jumping with agility when we attempt to catch it.

The vine altise in one month completes the cycle of its metamorphoses. The perfect insects that appear in Spring have passed the Winter under the bark, or in dry stone walls. As soon as the April sun has unfolded the vine buds, the altises devour the young leaves, and even attack the young shoots. When mated, twenty yellow eggs are laid by each female and fastened to the back of the leaf. Seven or eight days after, a little black larva, very much like a caterpillar, comes forth. This larva browses on the leaf, and at the end of fifteen days is full grown. It then crawls down the cane and buries itself about four inches deep in the ground; at least that is the depth at which I found the pupæ raised in my laboratory at the School of Agriculture. There it forms an oval cell, in which it goes into the pupal state. This pupa is white at first; the fourth or fifth day the anterior part of its body turns brown, and at the end of a week it is transformed into the perfect insect. Twenty-four hours suffice for the teguments of the altise to become sufficiently strong for it to be able to come out to the light. We have as many as five generations of these insects a year in Languedoc, and this number must be exceeded in Spain and Algeria, where this species abounds. The Summer generations do little harm, the insect being scattered over the numerous leaves, whose veins, grown firm, are spared by its mandibles.

This insect is destroyed by dropping it into the tin funnel (Fig. 29) mentioned in connection with the white snail. Furthermore, it may be caught in the larval state in June, by taking off four or five leaves at the base of each cane, where it is usually found at this time of year. Moreover, it may be hunted by broods of chickens, turkeys, or ducks, who can catch it very readily.

D. Gribouri (*Adoxus vitis*).—The gribouri, often called "writer," from the marks it leaves on the leaves, is one of the most dangerous enemies of the vine. It is a small beetle, with chestnut colored elytra and corselet. It flies, but does not jump like the altise.

Its larva, according to Mr. Valéry Mayet, is underground, and resembles somewhat the larva of the cockchafer, being crescent-shaped like it. It attacks the root of the vine, under which it makes longitudinal grooves, where it remains buried, which renders it very difficult to find.

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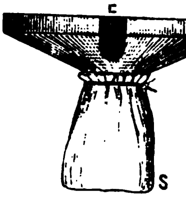
[1] *Des Insects Ampélophages autres que le Phylloxera*—Lecture delivered February 7th, 1879, at the prefecture, by Valéry-Mayet, Professor of Entomology at the National School of Agriculture at Montpellier. Montpellier, imprimerie centrale du Midi, Hamelin Freres, 1879.

It is sometimes so abundant that it kills the plants attacked by it, making circular spots in the vineyards that are seen from afar, and many times taken for the phylloxera spot.

When the time for its transformation into the pupal state has come, that is to say the first part of May, it digs itself an oval cell in the ground, closing itself within, where it undergoes its metamorphosis. The pupa is white, and especially remarkable for the curved spines that arm the end of the abdomen, and also the extremities of the anterior and posterior legs. These spines facilitate their movements very much. The pupa, placed on a table, moves along by catching hold with these appendages, and I would not be astonished if, disturbed in its underground cell by the pickaxe or plow, it could succeed in burying itself anew at a certain depth.

The perfect insect appears in June, and immediately begins to eat the vine leaves. It attacks them about the middle, making little elongated cuts resembling the wedge-shaped characters in the writing of the ancient Assyrians; hence, the common name of *writer* given to this insect. It is also called *bête à café* in certain villages in the district of Béziers, in allusion to the color of its elytra. It is difficult to come near this insect; at the least noise it contracts its legs and falls to the ground as though dead. However, with a little practice it may be gotten rid of like the altises, early in the morning, by means of a funnel hollowed out and terminated by a sack (Fig. 29). At Florensac (Herault), last year, I saw peasants come into the city at eight o'clock in the morning with sacks, each holding more than a pound of these insects. The only efficacious remedy for the larva is cakes of rape or mustard seed. Baron Thénard, in eighteen hundred and fifty-four, recommended them in a memoir to the Academy of Sciences. The chief insecticide in these cakes appears to be the essence of mustard, which is long enough in evolving for its action to be a prolonged one, which kills the larvæ of the Gribouri.

Fig. 29.



Altise Trap.

E. Pyrale (*Pyralis Pilleriana*).—After phylloxera, the pyrale may be considered as the most dangerous enemy of the vine. It has made very considerable ravages in Bourgogne, and since in Languedoc and throughout the South. We shall give the following account of it, taken from the author previously mentioned:

> The Pyrale has but one generation a year. The eggs, twenty in number, are laid on the leaf in August. The little caterpillar hatches out in September; hardly one tenth of an inch, long, it lives all Winter under the bark, after being previously enveloped in a white silk cocoon. At the end of April, or the first part of May, it leaves its hiding-place and ascends the young shoots. It joins several leaves together by means of silk threads, and thus forms a sheath, where it will have food and shelter. When, at the end of several days, the half-eaten leaves are withered, the caterpillar makes a new sheath, and so on, until it is fully developed. Very often clusters of flowers are inclosed in these sheaths of leaves, and it is easy to see how much is compromised in a plant nourishing, sometimes fifty of these enemies. This caterpillar is relatively large, greenish, with a black head. At the end of June it is full grown, and is transformed into a pupa. A little more than two fifths of an inch long, this chrysalis is suspended by the extremity of the abdomen, inside the last sheath of leaves made by the caterpillar. The perfect insect comes out in July. It is a small butterfly, of a yellowish gray color, with three transverse bands of a reddish brown on the anterior wings, the posterior are blackish, a little lighter towards their base. About the middle of August all the eggs have been laid.

The principal methods proposed for destroying the pyrale are the following:

First—Scalding the vines with boiling water. The water is boiled in little portable boilers, placed in the midst of the vineyard; the hot water is then carried in a sort of coffee-pot, having a spout, and poured over the old wood of the vine, so as to scald the little caterpillars hidden under the bark. This method is inconvenient, in that it necessitates the use of very hot water, ninety degrees at the least, (194° Fahr.), which it is not always possible to obtain, as it must be carried some distance before applied; then, it does not always allow of properly reaching the underside of the almost horizontal arms of the vines, so that a certain number of insects often escape its effects.

Second—Application of Sulphur.—The vines, after pruning, are covered with a bell-shaped cover of zinc, or petroleum barrel cut in half, under which sulphur is burned on a plate, or two or three sulphur matches. The operation should last five minutes at the least, that the atmosphere may be well saturated with sulphurous acid, and ten minutes at most, for fear of disorganizing the buds, which are easily injured by a too prolonged action of this gas. The results of this method were generally satisfactory in the vicinity of Montpellier, in 1873 and 1874.

Third—Washing vines with the following mixture, invented by Mr. G. Bazille, and used by him in his estate at Saint Sauveur, which is very subject to attacks of the pyrale, may be equally recommended:

Cow's urine—pounds	220.55
Heavy gas oils—pounds	13.233

The oil is mixed in by means of a certain quantity of soft soap put in the urine. The liquid thus obtained is applied to the vine with a coarse brush. These divers methods may be used in Winter, during repose of the vegetation.

F. Cochylis (*Cochylis Roserana*).—Mr. V. Mayet gives the following account of this insect:

> This little butterfly, also, is a terrible enemy to the viticulturist. Its ravages have never equaled those of the pyrale, but it is perhaps more difficult to be destroyed. The cochylis has two generations a year. It lives during Winter under the bark in the chrysalis state, enveloped in a gray silk cocoon. In April, the perfect insect hatches out, mates, and lays its eggs. It is seen in the daytime flying from one vine to another in the form of a small glittering yellowish white butterfly, its anterior wings crossed by a large band of lilac brown. The caterpillar of the first generation is greenish. It makes a sheath with leaves and clusters of flowers joined by silk threads. The metamorphosis into the chrysalid state takes place in June, and the butterfly hatches out in July. In August and September the caterpillars of the second generation appear. They are reddish in color; much more to be dreaded than those of the Spring; they attack only the grape. They pierce the berry to feed on the pulp, and, passing from one to another, the whole bunch is soon destroyed. When, at the end of August, the vines are found to be attacked by the cochylis, there is no time for hesitation; the grapes must be picked green. If there was any delay, not only a fifth or fourth of the vintage would be lost, but four fifths, and perhaps the whole. This method has the advantage, moreover, of destroying nearly all the caterpillars. The cochylis alights especially on the ordinary varieties used for white wine, such as the *Picpoul* and *Terret Bourret* of Europe. And the inconvenience in making white wine with green grapes is not great. What is lost in alcohol is gained in acids useful in the preservation of the wine.

G. Noctuelle (*Noctua Aquilina*).—The caterpillar of the noctuelle (gray caterpillar), is polyphagous; therefore, it does not always attack vines. For instance, it often abandons them when the vineyard is overrun with weeds. But when circumstances cause it to seek its nourishment on this plant, its ravages are greater if it attacks the vine just as it is beginning to grow. Not content with eating the leaves, it often cuts the young canes, causing not only the loss of the vintage, but frequently greatly disturbing vegetation as well. The grafts of the current year suffer particularly from its attacks. The gray caterpillar, like the butterfly, is nocturnal. It passes the day buried in cracks of the ground, whence it comes forth to eat only at night.

This insect is gotten rid of by hunting for it by hand around the root of the vine, which it does not go far from; usually it is found within a radius of about one and one half feet and at a depth of about one inch. Or else two or three holes may be dug around the vines with a wooden stake, having a somewhat blunt point; the caterpillars on leaving the vines, towards morning, accumulate there and are crushed with the stake that has been used in digging the little holes.

3. *Vegetable Parasites.*

The principal vegetable parasites that attack vines in our climate, are Oïdium, Anthracnose, and Mildew.

A. Oïdium (*Tuckeri*).—Oïdium attacks the vines in the following way: The green parts are covered with a whitish dust, emitting a peculiar musty odor; after a while, gray spots appear on the parts invaded; then, if nothing is done for it, its effect is soon made apparent in stunting of the canes, dying and premature falling of the leaves, and finally chapping and drying of the grapes, which lose all value. Certain species and varieties of vines seem more susceptible than others to attacks of this parasite. Thus, while the *V. Labrusca* entirely escapes it, and the *V. Æstivalis* is but little harmed by it, the *V. Vinifera*, on the contrary, suffers much from it, especially certain varieties, such as the *Carignane* and the *Piquepouls;* the *Grenache* or *Alicante* and the *Morrastel* resist it somewhat better.

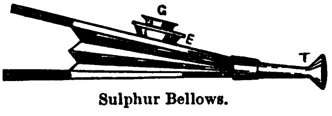
Warm and moist weather are most favorable for the development of oïdium. Vines trained on high trellises are attacked the worst, as they, more than others, catch the germs of the cryptogams, borne along by the wind. The means now generally adopted for combatting oïdium is the use of sulphur. Only sublimate sulphur was used at first; now triturated and bolted sulphur especially is used, which is cheaper, adheres to the leaves better, and is less trying to the eyes of the workmen applying it.

FIG. 30.

Sulphur Dredger.

The tools with which sulphur is applied, are the following: The dredge (Fig. 30), a sort of tin cone, pierced with holes at the base, which is filled with sulphur, and by means of which the leaves and fruit are sprinkled. This apparatus is inconvenient, in that it uses too much sulphur (three times more than the bellows) and distributes it badly. Second, the sulphur bellows (Fig. 31); the instrument most generally used is an ordinary bellows, without any valve underneath, and having on the upper side an opening provided with a funnel, E, for pouring in the sulphur, and a blast-piece, T, supplied with a grating, for directing the jet. The instrument once filled, and the feeding hole closed by means of a stopper, G, every exhaustion of the bellows causes a certain quantity of sulphur dust to rise, which is then expelled by expiration. The sulphur is disseminated well enough by means of this tool. It should be preferred to the dredge. Third—The Pinsard apparatus for sulphuring[1] (Fig. 32), is a large tin receiver, in the form of a funnel, R, capable of holding from twenty-seven to thirty-three pounds of sulphur, and may be fastened to the back by means of straps, B, passed over the shoulders. The lower part of the funnel is prolonged by an India rubber nozzle, C, ending in a little reservoir, r, surmounted by a cylindrical bellows, S, and terminated by an elongated blast-piece, T; a spring attached near the top of the large receiver, R, and in the little reservoir, r,

FIG 31.



Sulphur Bellows.

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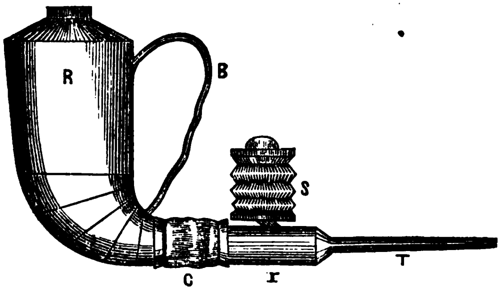
[1] Montpellier, Chez Vidal, Dépositairs d'Instruments Agricoles, rue Saint Roch.

serves to draw the sulphur into the latter at each movement communicated to the India rubber conduit.

FIG. 32.



Sulphur Apparatus.—R, principal recipient; C rubber tube; r, reservoir; T, tube or nozzle; S, bellows; B, handle.

The apparatus is worked as follows: The workman walks along parallel to a row of vines; at each step, with his right hand he raises and lowers quickly the blast piece; then, by pressing suddenly on the bellows with his left hand, he expels the sulphur, which is sprinkled in a very fine cloud over the surrounding vines.

On the whole, the Pinsard apparatus presents the following advantages: In the first place, it allows a sensible economy in hand-labor, and rapid execution; in fact, a workman with this apparatus can get through with two hectares (hectare=2 A. 1 R. 35 P.) in half a day. Moreover, it realizes a notable economy in the quantity of sulphur used, on account of its not having to be filled often, which is always attended with loss, and of the excellent diffusion of the sulphur. Therefore this instrument must be considered as the most perfect of those that have been used up to the present time in the South.

Vines are usually given three doses of sulphur in the course of a year. The first is given in May, when the vine is in bloom; it requires about thirty-three pounds of sulphur (applied with the bellows) to the hectare; the second is given from the fifteenth to the thirtieth of June, in a dose of sixty-six pounds; then the third is given in July, at the rate of from eighty-eight to one hundred and ten pounds, which makes, in all, from two hundred and ten to two hundred and twenty pounds to the hectare a year.

Conditions favorable for the satisfactory application of sulphur are, dry and warm weather, leaves devoid of moisture, a light wind which facilitates the dispersion of the sulphur, and, finally, a temperature reaching from twenty-five to thirty-five degrees centigrade (Fahr. 77° to 95°) during the day.[1]

B. Anthracnose.—Anthracnose is a disease caused, like the preceding, by a microscopic fungus (probably the Phoma vitis). It is usually manifested by spots or pustules that appear on the green parts (young canes, veins of the leaves, and green grapes). Some of these spots are areolar and wholly black (Dunal's dotted anthracnose), others are more or less elongated, irregular, and edged with black (clouded anthracnose of the same botanist); at first small, the latter enlarge little by little and become hollow. The injuries they produce may cause stunting of the canes, whose growth is arrested as by a series of successive pinchings, curling of the leaves, a stopping of the growth of the grape, the vintage sometimes being entirely lost, and probably other evils not well known as yet.

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[1] See Mr. H. Maré's excellent treatise (*Soufrage des Vignes Malades*, etc.; Montpellier, 1856. F. Seguin, libraire editeur), now a standard work on this subject in the South.

It is especially in wet years, in low soils and foggy climates, that anthracnose commits its ravages. The vines most frequently attacked are the *Carignane*, *Clairette*, *Brown Fourca*, and *Teoulier* of *V. Vinifera;* the *Pauline*, that has it, as it were, in an endemical state and peculiar form, and the *Jacquez* among the *V. Æstivalis;* finally, the *Solonis*, of the *V. Riparia.*

The remedies used are: Powdered slacked lime, sprinkled over the vines several times during the Summer, and sulphur, which is used at the first appearance of the disease, and which must be applied at short intervals (eight or ten days) until it is checked. It has also been suggested to wash the vines, at the end of Autumn or during Winter, with a solution of sulphate of iron (green vitriol)—five or six pounds diluted, warm, in six or eight quarts of water. This quantity would be sufficient for a thousand vines.

C. Mildew (*Peronospora viticola*). This cryptogam that commits very considerable ravages in the United States, is probably old in Europe, where it is much less dangerous. It appears in the form of white spots resembling a saline concretion, adhering to the under side of the leaves.[1] The pulpy substance of the latter becomes yellow and is soon disorganized, and the leaves sometimes fall, thereby arresting vegetation; the wood then does not ripen well, and the fruit ceases to develop. It is on the tender leaves of young plants, and on vines growing in low and moist places or exposed to sea-winds, that the disease appears in its worst form. Rains, fogs, and moist winds constitute the atmospheric conditions most favorable for its development; the dry northwest winds, on the contrary, suddenly check its spreading.

The varieties most attacked are, among the *V. Vinifera*, the *Carignane*, and other varieties of the extreme East, in the *V. Æstivalis*, the *Jacques*, and among the *V. Riparia*, varieties with glossy leaves.

The only means known at present for checking the ravages of this parasite is sulphate of iron, used as directed for anthracnose; applying sulphur, as it is used in the case of oïdium, has met with no success, however, it seems, fortunately, that there is no need of paying serious attention to this subject in our climate.

4. Diseases.

Chlorose.—Chlorose is manifested by yellowing and discoloration of the leaves, owing to an insufficiency of chlorophyl; it is generally worse in lands that are humid in Winter, becoming slowly warm in Spring, and losing a great proportion of water in Summer; or in those completely lacking certain elements beneficial to the vegetation of the vine.

The varieties most easily attacked are the *Herbemont*, *Norton's Virginia*, and *Hermann*, of the *V. Æstivalis;* the *Marion*, *Clinton*, and wild varieties with small leaves, of the *V. Riparia*, and a great many of *V. Labrusca*, the *Concord* among others. Although the chlorotic state of a grafting stock may be considered as unfavorable to good vegetation of the vine grafted on it, it often happens, however, that if this latter is not in itself subject to chlorose it keeps perfectly green; this fact has frequently been remarked in cases of grafting the *Aramon* on *Herbemonts* or *Clintons* attacked with chlorose.

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[1] These spots must not be confounded with the galls of the crineum. The latter are honeycombed, and consist of protuberances on the upper surface of the leaf.

When the disease seems to be due to excessive humidity of the soil in Winter, the ground should be drained and improved in such a way as to favor drainage of the water. In every case the soil must be dressed with manure, actively and quickly dissolved, such as suitable chemical composts, guano, dung, dessicated nightsoil, and oil cakes mixed with salts of potash and sulphate of iron; the last salt appears to have a most advantageous effect on chlorose.

PART SECOND—SUBMERSION.

Submersion consists in covering the vineyard with water for a length of time sufficient to destroy the phylloxera. The use of this means involves the establishment of the vineyard under certain special conditions, which will be given first; we shall then examine the installations necessary in its practice, the manner of doing it, and peculiar cultivation entailed by it.

CHAPTER I.

CONDITIONS NECESSARY FOR THE SUCCESS OF SUBMERSION.

The conditions necessary for the success of submersion are the following: First, possibility of procuring a sufficient quantity of water at the proper time, without too great trouble; second, application of this water to soils susceptible of receiving it in regular sheets and of holding it there; and third, to varieties not in danger of suffering from the effects of this treatment.

1. Water.

A. Necessary Quantity.—Submersion generally requires great quantities of water; this quantity varies according to the permeability of the soil, and the duration of the operation. Mr. Fancon estimates the volume necessary at his place at three thousand five hundred cubic metres per hectare, but this amount appears to be the minimum, and is certainly greatly exceeded in most cases. Usually, ten thousand to fifteen thousand cubic metres, and sometimes as much as thirty thousand cubic metres should be reckoned for the hectare. Part of this water must come in an almost continuous flow, to guard against loss by absorption or evaporation.

B. Quality of the Water.—Regarding it as an insecticide, water charged with air, such as that raised by machines, or that which has lately fallen from a height, must be considered as least efficacious, since the smallest bubbles are sufficient to prolong the existence of phylloxera. That which is completely deprived of fertilizing substances is likely to exhaust, more or less, the somewhat permeable soils washed by it.

But this inferiority is only of secondary importance, in a practical point of view, and submersion should not be renounced because only water of this nature is procurable, as long as other circumstances render it possible.

2. *Soil.*

A. Permeability.—In order that land may be submerged, it must not be too permeable in itself, or through the nature of its sub-soil. Permeability is not only an obstacle, owing to the waste of water it entails, and the dilution resulting from the current established in the soil; but moreover, it aids in the formation, in the sub-soil, through the descent of the water, of quantities of little air bubbles that, as we have seen, favor the persistence of phylloxera. Clayey sub-soils, calcareous clay, or compact silicious clay, generally realize the desired conditions best; those that are pebbly, or formed by disintegrated rocks, have, on the contrary, often given rise to failure.

B. Inclination and Relief.—Land that is to be submerged should be horizontal, or but slightly inclined, about two to three per cent. at most. Great inclinations necessitate a great deal of embanking, which is expensive and sadly diminishes the area of the checks. Moreover, the surface of the ground must be sufficiently regular, in order that there may not be too great differences in the height of the water in the divers parts immersed.

3. *Adaptability of Varieties to Submersion.*

Not one of the varieties that have been submerged up to the present time appears to have suffered directly from its effects, but many of them have been more severely attacked, owing to this treatment, by certain affections or accidents to which they are predisposed by nature.

The *Clairette* and *Carignane*, for example, which are subject to anthracnose, are often a little more severely attacked by this disease when submerged than when under ordinary conditions; the *Grenache* or *Alicante*, which ripens late and imperfectly, is often stopped in its growth by immersion, especially when it is done rather early.

The *Aramon*, *Espar* or *Mourvèdre*, *Petit-Bouschet*, *Moustardié* of Vaucluse, *Cot*, *Cabernet-Sauvignon*, *Syrah*, and *Chasselas* have been submerged without ill effects.

CHAPTER II.

MEANS OF SUBMERGING.

1. *Source of the Water.*

The water to be used in submersion comes from natural streams, from canals, ponds, reservoirs, springs, artesian wells, or even drains.

It may be brought to the vines to be submerged by gravitation, by means of elevatory machines, and sometimes by simple temporary stopping up of drains or other conduits.

A. Gravitation.—The first method is evidently the simplest, and must be used whenever the water may be carried without difficulty from a higher level; it involves no other expense than that of building a canal.

B. Machines.[1]—Unfortunately, we cannot think of applying gravitation in every case: The impossibility of building dams in some streams of water, the slight inclination that necessitates going a long distance for the water, and crossing many other people's property; finally, the intermittent flow from some canals, often render it necessary to use the second system. The elevatory machines most generally used are rotary pumps (especially Neut and Dumont's and Gwine's), and the wheel invented by Mr. Dellon, engineer at Montpellier, and built by Mr. Bergeron, at Nimes.

The rouet appears to yield a superior flow to that of the rotary pumps for heights less than sixteen feet, but is inconvenient in not being as easily moved about as the latter, and in not being so well adapted, consequently, to exigencies in submerging vineyards that are broken up, or indeed where it is desired to utilize the water used in submersion for Summer irrigation in land at some distance from the vineyard. The *noria* and *tympan*, also, have been used for raising water, but these machines have only given results inferior to those of the preceding ones.

The divers apparatus that we have just mentioned are generally worked by steam engines; these motors may be considered, in many cases, as the only ones possible; they are generally the most convenient. The cost of the operation by their means varies between sixty and eighty francs per hectare, when not exceeding sixteen feet, a height beyond which there seems to be little need of going in practical use. This price is not higher than that demanded by most syndicates or societies of canal irrigation.

The machines are sometimes put up, immovable, on a culminating point, so as to have full sway, by a system of suitable canals, over the whole extent to be submerged. At other times they are movable and may be taken successively to bear upon the portions of land it is desired to treat. The first system should be preferred wherever possible; in fact, it allows of using steam engines attached to an independent generator, which do the work cheaper and last longer than movable machines. Moreover, by this method we avoid the loss of time in starting the machine to running, which results from moving it about. Finally, by a well-contrived distribution of water throughout the vineyard, the work may be better proportioned and its duration shortened.

It is possible, under some circumstances, to substitute for steam the force furnished by the current whence the water necessary in treating the vines is taken. In this case, turbines or water-wheels are used as motive machines. The work is then done very economically. For important operations, it may perhaps be found advantageous to combine the action of wind, too irregular to be used alone, with that of steam.

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[1] See Appendix, note IV.

Whatever may be the motive power used in raising the water, the latter is generally brought within reach of the elevatory machines by means of *roubines;* that is to say, ditches dug at a little lower level than that of the lowest water in the river; we should be able, at need, to shut off the power by means of sluices conveniently placed. In this way the sometimes considerable embanking that would be required if the machine was situated on the water's edge, is avoided. When there is danger of impairing the ditches along the river, the water may be conducted over them by a suction pipe forming a siphon, which communicates with a rotary pump.

C. Obstruction of Drains and Conduits for the Flow of Water.—Land long since rescued from marshes and ponds may sometimes be submerged by causing it to return temporarily to its former condition. First, the bottom is leveled off, so as not to have too great a difference in the depth of the water; then the lower part, through which the water escapes, is closed up by means of embankments and sluices conveniently disposed; then, when there is drainage the pipes at the lower part of the field, which it is desired to put under water, are closed up all the time the work is going on. The submersion once ended, all the conduits are reopened that the soil may be drained. This system, which unites remarkable economy of installation and execution with great efficacy, has been repeated many times with good success.

2. *Outline and Establishment of Checks for Submersion.*

Water is held on the ground by small dikes or embankments which form the perimeter of the submerged checks.

A. Form of the Checks.—It is endeavored to make the checks rectangular; these in fact, are most convenient for cultivation, and correspond best to the system used in planting. In horizontal land, where they may extend far out in every direction, it is well to make them square, for the square, of all the rectangular figures, incloses the largest surface in proportion to its perimeter, and consequently fewer embankments are needed; moreover, it facilitates cross plowing, the efficacy of which is generally understood. In land that is slightly inclined, the checks are made rectangular, the long side following the mean proportionals of the inclination, in order, while preserving enough boundaries, not to exaggerate the height of the downward embankments.

B. Dimension of the Checks.—With regard to the destruction of insects, the largest checks are the best; in fact, there is then less embankment in proportion to the surface than in small checks; now, the roots, penetrating the embankments, are seldom well cleared of insects, and in Summer constitute a center of infection, whose development must be abated as much as possible. But it is generally impossible, practically, to carry out the application of this principle to its utmost extent, which would necessitate making but a single check of the whole vineyard that is to be submerged. The obstacles generally in its way are: First, the ground not being horizontal, which necessitates the inclinations being divided into several sections to avoid the construction of too high embankments; second, the impossibility of putting on enough water at a time to fill the check; third, the danger of the banks being washed away by the waves that the wind raises on large sized checks; fourth, finally, the fear of the inconvenience that would arise, for the whole submersion from an accidental break occurring in the single inclosure. In short, the dimensions that appear to be best, when they are possible, are those inclosing from seven to twenty-five acres.

The checks should be carefully laid out, so that the surplus water of the highest ones flows into the others; for this purpose little slopes are built of stone, or simply of wood; but it is well, moreover, for each one to be able to receive the water independently through a special canal. Finally, ditches, and sluices must be carefully arranged that the land may be drained easily after the operation.

C. Embankments. The embankments should be constructed in the form of a prism with a trapezoidal section, and of an inclination of forty-five degrees. This form assures them the greatest solidity, and less danger of breaking down, and affords better chance of passing over them in order to get around the vineyard while it is submerged. The size of the small base depends upon the pressure the dike must endure; that is to say, upon the depth of water it has to hold in. It generally varies between twenty inches (for heights of twenty inches and under) and forty inches (for those of from twenty to forty inches). When the checks are very large, instead of little embankments like those we have just described, veritable roadways may be built for the vintage and dung carts to pass along.

It is seldom necessary to construct embankments more than one metre high; beyond this limit there is danger of the vines disappearing entirely under water, which may be injurious to them. The embankments, in every case, should be capable of holding in a sheet of water ten inches deep, and should extend from six to eight inches above it, so as to keep back the waves that are sometimes raised by the wind. Finally, these structures must be made ten per cent. higher than the definitive dimensions to allow for their settling.

The embankments should be built before planting, so as not to risk injuring the young vines, and to give the earth time to settle before submerging is begun, but they must not be commenced until the ground is leveled and tilled. The earth that has to be used in constructing them may be taken from the premises here and there, where they are to stand, but specially on the lower side, where the ground must be leveled off a little more than on the upper.

It is well to preserve the embankments from being worn by the action of the water by turfing them; but not covered with plants that afterwards might contaminate the vines with their seeds or the spreading of their roots. What appears best for this purpose is creeping clover (*T. repens*), which, without being greatly incommoded, can pass from a state of excessive moisture to one of considerable drought; moreover, on account of the creeping character of its stems, the nodes of which take root on contact with the ground, it forms a compact and firm covering for the earth. In places very much exposed to the wind, and in large checks, it is also well, while the ground is submerged, to line the parts of the banks that are washed by the waves with brush, boughs, or reeds, held in place with iron-wire.

CHAPTER III.

HOW TO SUBMERGE.

1. Time.

Mr. Faucon has observed that the time when phylloxera can be best affected by the action of water is that corresponding to the most active period of its life, from April fifteenth to October fifteenth, and sometimes later; during Winter, on the contrary, when the insect is in a torpid condition, it is affected much less easily by it. Summer, therefore, would have to be chosen for the treatment if we had only to consider its efficacy respecting the insect, but we must also take into consideration the life and cultivation of the vine, which would suffer from a prolonged submersion during that season, and could not always be cultivated at the proper time. During repose of the vegetation, on the contrary, water ceases to do harm, and work usually being suspended from this time, leaves the field free to be inundated. When the canes are perfectly ripe, water may be turned on without danger; then, generally, the sooner from this time on it is done the better. Most of our southern varieties are in the required condition about November first. The *Grenache* or *Alicante* and the *Carignane* are not always woody enough at this season, therefore submersion should be put off in their case until they have come to the desired state. It was through having neglected this precaution that the first of these varieties was frequently injured, when submersion was first tried.

2. Duration.

The duration of submersion must vary according to diverse circumstances, the most important of which are climate, nature of the soil, and the season.

A. Influence of Climate.—Experience has proved that, in the most northerly part of our region[1], the duration of submersion may be shortened to twenty-five or thirty days, while in Herault, Gard, and the Bouches-du-Rhone, it is extended to thirty-five or forty days at the least. This is easily explained by the fact that phylloxera multiplies less in cold climates, so that we can afford to leave a much larger quantity of living insects there than in the South, which otherwise would result in great inconvenience. It is probable that altitude will have the same influence as latitude, and that on the high plateaux of the southern region, the duration of submersion may be relatively short.

B. Influence of Soil.—Compact soil, having an impermeable subsoil, does not need to be kept under water as long as that of some permeability, or that overlying a pebbly or fissured subsoil; in fact, the first is rid of air sooner than the latter and consequently the insect succumbs sooner there.

C. Influence of the Season.—The season also has an influence upon the duration of submersion, because phylloxera, as we have seen, during the period of its greatest activity, is more easily affected by the action of water; so that in Autumn, the time of year when it lays its eggs in our southern climate, it will be more readily destroyed than during Winter, when it is completely torpid. While in the former season the vineyard must be submerged for thirty-five or forty days, forty, or fifty, and sometimes more are needed when the work is carried on during the latter.

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[1] For instance, Mr. Morin Latour's place at Livron (Drôme).

In short, the duration of submersion will have to vary, according to the circumstances just given, from thirty to fifty, and even sixty days. Moreover, throughout its duration, the water must cover the ground in a sheet at least eight or ten inches deep, and remain there continuously. A great many failures or accidents have resulted from not following out these last directions, which, however, were given from the first by Mr. Faucon; the least deviations, in fact, are sufficient to introduce air, which allows the life of the phylloxera to be prolonged, sometimes sufficiently for it to survive the treatment.

Therefore, when submersion is undertaken, too much attention cannot be paid to having only streams of water or canals that will furnish the water regularly during the whole time.

3. Age at which Vines may be Submerged.

When vines are planted anew in a once phylloxerated vineyard, it is well to submerge as soon as possible, beginning the first year, or even before planting, so as to destroy the insects that are likely to attack a great number of the young plants as soon as they take root, and do irreparable damage among them. When, on the contrary, the vineyard is set out in land free of phylloxera, as a general thing it need not be put under water until the end of the second year. A careful examination of the roots, however, will determine when it is necessary to begin the work; it should be commenced without hesitation at the first appearance of the least trace of ill, that there may not be great damages to repair.

4. Repetition of Submersions.

Submersion should be repeated every year. In fact, although the treatment, when effected under good conditions, may be considered as the most perfect insecticide, and though in Spring, in some years, it may be impossible to find an insect on vines that have been subjected to it, yet the latter are reinvaded every Summer, as proved by Mr. Faucon, by the aptera crawling along the ground and the winged ones transported by the wind, which come from neighboring plantations. Therefore it is necessary, every Winter, to again rid the vines of insects that came to them in Summer, and which, multiplying, would be able to commit great ravages.

CHAPTER IV.

PLANTATION AND CULTURE.

Plantation and cultivation of vines, treated by submersion, are, in a general way, subjected to the same rules as those given in the case of American vines; we shall limit ourselves to pointing out the several precautions requisite in these operations when this treatment is used.

1. *Plantation.*

Plantations that are to be submerged should, still less than the others, be composed of mixed varieties; in fact, as we have seen, water must not be brought to bear upon the vines until the wood is perfectly ripened, but it must be done at that time; now, it is impossible for these conditions to be fulfilled simultaneously in a bed stocked with different varieties; therefore these varieties must be separated and grouped in different checks, which may be submerged separately. Moreover, vines should not be planted too near the embankments; the roots penetrating them are, in fact removed from the action of the water, and remain attacked by phylloxera, which is a source of danger for the rest of the check, at the time of reinvasion; consequently, in order to prevent this penetration, the vines nearest the embankments must be at a distance from them, at least equal to half the regular space between the vines.

2. *Cultivation.*

A. Pruning.—Late pruning is especially advantageous in the case of vines treated by submersion, in lessening the chances of their being destroyed by hoar frost; we may begin with simple trimming, which is not followed by definitive pruning until the buds are swollen and ready to open.

B. Fertilizing.—Submersion has been accused of exhausting the soluble matter contained in the ground. This criticism, which does not appear well founded in the case of impermeable soil, is true, in a certain measure, when the soil is permeable; therefore it is well to supply the vineyard with fertilizers containing, in an easily assimilable form, the materials necessary for the current year only, and to repeat the application every Winter. The following formula, used by Mr. Faucon, answers the purpose very well: Rape seed oil-cake, ninety per cent.; Stassfurt's refined sulphate of potash (containing thirty-eight per cent. of potash), ten per cent., mixed together and applied in a dose of about nine ounces per vine. The chemical compost suggested by Mr. George Ville, and given in Part First, might also be used.

C. Tilling.—Submerged vineyards should be tilled frequently and with great care, on account of the settling resulting from the water remaining so long on the ground. In this case, more than any other, the ground must not be tilled at the time when hoar frost and coulure are to be feared, owing to the generally low and humid situation of the vineyard.

Finally, it is necessary to sulphur frequently, in order to combat coulure, oïdium, and anthracnose, which are often met with under the conditions in which submersion is generally used.

Such are the most important directions relative to this method of treatment. They may be considered as the resumé of experiences of the principal submerging viticulturists, and especially of Mr. Faucon, who has added to the honor of having been the initiator, that of finding, with rare sagacity, the solution of most of the problems arising in the application of this process.

PART THIRD—PLANTING IN SAND.

Sea sand acts as an important preservative against phylloxera in vineyards set out in it. Large downs have been planted for several years past, in the vicinity of Aigues-Mortes (Gard), for the purpose of utilizing this remarkable property. Although the methods of planting and cultivation used in these localities may be, on the whole, almost the same as those long used in the country, they are, however, somewhat different in detail, due to the special conditions under which they are applied, and which we consider it well to point out. We have also deemed it important to state the conditions of soil under which these plantations have thrived. This will be the topic of Part Third.

CHAPTER I.

CHOICE OF SOIL AND VARIETIES—PLANTING—CULTIVATION.

1. Choice of the Soil.

We shall examine this first question with respect to: first, the capability of the soil to render the vineyard phylloxera proof; second, the influence it may have on the good development of the vine.

A. Indemnity.—All sandy soils, that is to say, those in which the physical properties of sand predominate, are of more or less importance in prolonging the life of the vine, but only sea sand, containing more than sixty per cent. of silica, can be reckoned as absolutely phylloxera-proof. Calcareous sand does not preserve the vineyard from it as well as silicious sand; the former seems more easily agglomerated, and indemnity increases, up to a certain limit, with division of the soil. The existence, at a little depth, of a sandy, silicious, good subsoil, where a sufficient proportion of roots may develop, suffices to insure the persistence of a vineyard; in that case the roots growing in the upper layer are attacked and destroyed, but those penetrating the subsoil are preserved and nourish the vines.

B. Prosperity of the Vine.—Saving in low and salty places, the vine appears to thrive in nearly all the sea sands of Aigues-Mortes, even in soil encumbered with vegetable mould from pines and heather, and which is usually considered worthless. The almost general success met with in the sand of this locality, may be attributed to the rather large proportion (six per cent.) of phosphoric acid it contains; in fact the remarkable influence of this agent on vegetation in general, and especially in soil containing acid mould, is well known.

Of all the sandy soils where vines have been planted, those formerly planted with madder—that is to say, the richest and the first that were cultivated—have yielded the best results. As much as two hundred and fifty hectolitres per hectare (2.471 A.) have been obtained there—about two thousand five hundred gallons per acre. It does not seem that the accumulation of organic matter in their midst has in any way weakened their power of resistance to the insect.

Soil lying near the sea is less favorable to the success of the vine, the vintage there is much less, and, moreover, vineyards are there exposed to a greater number of accidents.

2. *Choice of Varieties.*

The *Aramon, Petit Bouschet, Cinsaut, Chasselas,* and *Carignane* have thriven more or less in sea sand. The *Cinsaut* appears best adapted to the pure sand in the neighborhood of the sea. The *Carignane,* on the contrary, which is very subject to anthracnose, suffers greatly from the effects of sea winds, to which it is subjected on the downs of our coast. The *Aramon, Petit Bouschet,* and *Chasselas* thrive extremely well, provided that they are supplied with the fertilizing materials necessary to insure an abundant vintage, and that they are not too much exposed to the sea wind.

3. *Planting.*

A. Preparation of the Soil.—The extreme lightness of the sandy soils seems naturally to render preparatory tilling useless, and yet experience has proved that it has great influence on the future prosperity of vineyards in these localities. This influence is explained, however, when we consider, on the one hand, the importance of the soil being well divided, with respect to resistance, and of its being aerated as regards assimilation of the fertilizing materials, and especially the phosphates which it contains. Therefore the soil must be tilled to quite a depth with a plow, followed by a Bonnet subsoiler. Sometimes this work is finished off by shoveling; men stationed at certain distances along the plowed land take from the bottom of the furrow of the subsoiler a spadeful of earth, which they throw on top of the plowed land. This kind of work is relatively inexpensive in soil of this nature, and consequently cannot be done too carefully.

B. Setting out the Vines.—Sometimes cuttings (rather long) which thrive very well in sand (where it is not salty or too near the sea), and sometimes rooted vines are planted; they are always set out in little holes dug with a shovel.

The quincuncial arrangement appears the most suitable one under the conditions we are now considering, because it allows the canes to cover the ground better and affords them protection from the wind.

4. Care of the Vineyard.

A. Fertilizing.—As far as possible, substances that will modify the physical properties of the sand, must not be used as fertilizers, otherwise there would be danger of rendering it non-resistant to phylloxera. The use of stable manure, even in large doses, appears to have been satisfactory up to the present time, but it may be asked if the prolonged accumulation of debris is not likely to prove injurious? Chemical composts and oil-cakes are evidently better suited to these conditions; by their means, azote and potash especially, are introduced into the soil, there being already a sufficient quantity of phosphoric acid there.

B. Summer Cultivation.—The few weeds that grow in sea sands do not necessitate frequent tilling, while the facility with which these kinds of soils are borne about by the wind, when dry, may cause this operation to be considered dangerous at certain times. Therefore, we are usually limited to tilling only once, at the end of winter. Then comes *enjoncage.* This operation consists in strewing over the ground rushes and other marsh plants that are then half buried in the soil with a shovel, or a sharp iron disk revolving in a *chappe* provided with a handle, just like a circular grass cutter. *Enjoncage* is to settle the soil until the Autumn rains come to give it some stability; for one hectare a thousand sheaves of rushes are used, which cost about three francs a hundred. When, in consequence of exceptional rains or other cause, the soil is rendered foul during the Summer, it must be weeded by hand, without giving it what is called second tilths.

Great attention must be paid to applying sulphur and powdered lime, on account of the considerable development, under the influence of sea winds, of the various cryptogamous diseases to which the vine is subject. Applying a solution of sulphate of iron would give good results.

APPENDIX.

I. List of American Varieties, Classified in Species, with their Aptitudes Indicated.

The following conventional signs will be used:

P. D.—Direct producer (cultivated for fruit).
G. S.—Grafting stock.
F.—Foxy.
D. C.—Difficult to propagate by cuttings.
N. R.—Non-resistant.
?—Aptitudes not sufficiently determined.

V. ÆSTIVALIS.

Alvey, P. D. Does not set well.
Æstivalis d'Elsinburg, P. D.
Baxter, P. D.
Black July (*Devereux Lenoir, Baldwin Lenoir*),[1] P. D.
Blue Favorite, P. D.
Bottsi, P. D., D. C.
Cunningham (*Long*), P. D., D. C.
Cynthiana (*Norton's Virginia*), P. D., D. C. Difficult adaptation.
Eumelan, P. D.
Elsinboro, P. D.
Herbemont (*Warren*), P. D., D. C.
Herbemont, Improved, P. D., D. C.
Hermann, P. D., D. C. Difficult adaptation.
White Hermann, P. D., D. C.
Humboldt, ?.
Jacquez (*Black Spanish*), P. D.
Lenoir, with large berry, P. D.
Neosho, P. D., D. C.
Neosho-Racine, P. D., D. C.
Pauline, P. D. Table grape, very subject to *anthracnose*.
Rulander (*Louisiana*), P. D., N. R.
Telegraph, ?.

V. RIPARIA.

Aughwick, G. S., F.
Blue Dyer, G. S., F.
Baron Perrier, G. S., F. Wild variety.
Clinton, G. S., F.
Clinton Vialla, G. S., F.
Elvira, G. S., F.
Franklin, G. S., F.
G. Bazille, poor G. S., F.
Huntingdon, G. S.
King Clinton, white, G. S., F. Very subject to *chlorose*.
Marion, G. F., S. Very subject to *chlorose*.
Oporto, G. S., F.
Taylor, G. S., F.
Taylor improved, G. S.
Scuperon (*sic.*), of the Acclimating Garden, G. S. Wild variety.
Solonis, G. S. Wild variety.
Uhland, G. S., F.
V. Vulpina, G. S. Wild variety.
Winter Grape, G. S. Wild variety.
Winslow, G. S., F.

V. LABRUSCA.

Adirondac (Canada), ? F. ?.
Belvider, ? F. ?.
Brighton, ? F. ?.
Blackhawk, ? F. ?.
Cambridge, ? F. ?.
Caroline, ? F. ?.
Cassady, ? F. ?.
Catawba, ? F., N. R.
Challenge, ? F. ?.
Concord, G. S., F.
Cottage, ? F. ?.
Creveling, ? F. ?.
Diana, ? F. ?.
Dracut Amber, ? F. ?.
Elizabeth, ? F. ?.
Hartford Prolific, ? F.
Iona, ? F. ?.
Isabelle, ? F., N. R.
Israëlla, ? F. Vigorous.
Ives Madeira, ? F.
Ives Seedling, ? F. Difficult adaptation.
Janesville, ? F. Vigorous.
Lady, ? F.
Logan, ? F.
Martha, ? F.
Mary Ann, ? F.
Maxatawney, ? F.
Muscadine, ? F.
North America, ? F.
North Carolina, ?.
Northern Early, ? F.

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[1] We consider it necessary to give here the synonyms most used in France. For a more complete study on this subject, see *Essai d'une Ampelograpie Universelle*, by Count J. de Rovasenda, etc. Traduit de l'Italien et annoté par le Dr. F. Cazalis et M. le Professeur G. Foëx. Hamelin Freres, Montpellier. (Published in April.)

Paxton, ? F.
Perkins, ? F.
Rebecca, ? F.
Rentz, G. S., F.
Schiller, ? F.
Seneca, ? F.
Telegraph (*Bush*), ? F. Difficult adaptation.
Tokalon, ? F.
Tolman, ? F.
Una, ? F.
Union Village, ? F.
Venango, ? F.
Walter, ? F.
Well's Large Black, ? F. Very vigorous.
White Fox, ? F.
York Madeira, G. S., F. Very rank, very resistant.

HYBRID VINES.

Allen's Hybrid, ? ?.
Arnold's No. 27, ? ?.
Autuchon, P. D.
Aminia, ? ?.
Black Defiance, ? F.
Black Eagle, ? F.
Black Pearl, G. S., F.
Brandt, ? F.
Canada, P. D.
Champion, G. S., F.
Chipewa, ? ?.
Christine, ? ?.
Clinton and Black Hambourg, ? ?.
Clinton Hybride, ? ?.
Conqueror, ? F.
Cornucopia, P. D., N. R.
Croton, ? F.
Delaware, P. D.
Delaware White, P. D.
Delaware and Scuperon, ? ?.
Delaware and Clinton, ? ?.
Ferrand's Michigan Seedling, G. S., F.
Florence, ? ?.
Greinn's Hybrid, ? ?.
Hager, ? ?.
Irving, ? ?.
Ithaca, G. S., F.
Noah, G. S., F.
Othello, P. D., ?. Vigorous.
Peter Wyllie, ? ?.
Prof. Planchon (*Schuylkill*), G. S., F.
Rickett's No. 10, P. D., ?.
Roger's Hybrid No. 1 (*Goethe*), ? F., N. R.
Roger's Hybrid No. 2, ? F.
Roger's Hybrid No. 3 (*Massasoit*) ? F.
Roger's Hybrid No. 4 (*Wilder*), ? F., N. R.
Roger's Hybrid No. 7, ? F.
Roger's Hybrid No. 9 (*Lindley*), ? F.
Roger's Hybrid No. 15 (*Agawam*), ? F., N. R.
Roger's Hybrid No. 19 (*Merrimac*), ? F.
Roger's Hybrid No. 28 (*Requa*), ? F.
Roger's Hybrid No. 30, ? F.
Roger's Hybrid No. 32, ? F.
Roger's Hybrid No. 33, ? F.
Roger's Hybrid No. 41 (*Essex*), ? F.
Roger's Hybrid No. 44 (*Herbert*), ? F.
Roger's Hybrid No. 53 (*Salem*), ? F.
Secretary, ? ?.
Triumph, ? F.
Wylie No. 5, ?.
Wylie No. 6, ? ?.

VARIOUS AMERICAN SPECIES.

V. Arizonica, ? ?.
V. Berlandieri (*Surrett Mountain*), G. S., D. C.
V. Candicans (*Mustang*), G. S., D. C.
V. Canescens, G. S., D. C.
V. Californica, P. D., D. C.
V. Cinerea, G. S.
V. Cordifolia, G. S., D. C.
V. Lincecumii (*Post Oak*), ? ?. Difficult adaptation.
V. Rotundifolia (*Scupernong*), ? ?.
V. Rupestris, G. S.
Grand Noir, of the Acclimating Garden, F. ?.

II. Note on American Wines.

Mr. Saint Pierre, Director and Professor of Technology in the Agricultural School of Montpellier, thus sums up the result of his researches in American wines:

[Extract from the *Vigne Américain*, June number, 1878.]

Of all cultural researches, œnological and economical, pursued in the Agricultural School of Montpellier on the subject of American varieties, the study of wines furnished by these varieties has engaged my whole attention since 1875. While problems of resistance, pruning, or grafting require some time to be solved, the appreciation of the qualities of a vine is much easier, and above all more rapid.

I am now convinced that there are no longer any reasons for doubting the value of wines obtained from many American varieties, and I deem it well to recapitulate, with great emphasis, the conclusions contained in the special memoirs that I have published on this subject.[1]

A.—A first point, which it is important to establish, is the perfect maturation, in the southern climate, of grapes of the *Æstivalis, Cordifolia,* and numerous vines belonging to the *Labrusca* or *Hybrids*. Grapes gathered in Montpellier in 1874, 1875, 1876, and 1877, were all properly ripened, and presented no more variations in quality than the French varieties of corresponding vintages.

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[1] C. Saint Pierre et F. Foëx, *Rapport sur la Composition des Vins Américains:* Montpellier, 1875 C. Saint Pierre, *Étude sur le Vin du Clinton:* Montpellier, 1876. C. Saint Pierre, *Recherches sur les Vins de Cépages Américains Récoltés en France en* 1876*:* Montpellier, 1877. C. Saint Pierre, Nouvelles Recherches sur les Vins des Cépages Américains Récoltés en France en 1877. (*Messager Agricole*, June, 1878.)

In this way the musts of the following varieties: *Jacquez, Clinton, Rulander, Cynthiana, Black-July, Elvira,* and many others, are always found to be sweeter and richer than the musts of our best southern varieties.

As to whether maturation may be effected in other viticultural regions of France, I think I may say it can. Comparing, in the collections of the School of Agriculture, the relative maturation of American varieties with the maturation of divers French varieties (*Petite Syrrha, Marsanne, Black Pinot, Black Pulsart, Maldoux, Cabernet,* etc.), I have always noticed that at the same time, that is, the first fortnight of September, the advantage is on the side of the American varieties, and, consequently, I have no doubt of their maturing before the fifteenth of October, in the vineyards of Bordelais or Bourgogne.

B.—For these wines, several categories may already be established answering to the various classes demanded by commerce—we find white wines and red wines. Among these last, the wines of the plain are represented by the *Herbemont*—the color and savor remind one of those of the *Aramon*—the alcoholic richness is nearly the same.

The fine mountain wines of the south of France find their equivalent in the *Black-July, Jacquez, Norton, Eumelan,* and *Cynthiana;* color, alcohol, savor, body, and preserving qualities. Nothing is lacking in these productions to make them equal to the good wines of the hills of Provence or Roussillon.

Among them, the *Cynthiana, Black-July,* and no doubt others, may acquire a degree of fineness, a bouquet, and a Rancio color that will bring them still nearer the wines of Roussillon.

Commerce would also find wines from American varieties similar to the wines used for blending produced by the *Narbonne* and *Banyuls;* the color and richness of the *Jacquez, Clinton,* and *Norton,* are in no way inferior to those of the French colored wines. I will add that this color, in its characteristics and reactions, is comparable to that of our French wines—it is subjected, in wine making, to the same influences as the color of the *Narbonne* wines, and is adapted to the same blending and changes through age or heat, while presenting the same tints.

Unfortunately, I have been told the *Clinton* wines have a disagreeable taste. If commerce did not utilize the *Clinton* (the only foxy wine of all those I have enumerated above), the list would then be long enough to satisfy all needs. But I do not despair of seeing the wine from the *Clinton* almost completely lose the foxy taste through blending, age, clarification, and especially fermentation. Putting gypsum in the fermenting vat, acidification of the must, separation of stems and skins, early vintages, such are the means I have studied so far, and which have given me very encouraging results. By an intelligent association of the above conditions, we shall certainly obtain wines from the *Clinton* qualified for consumption.

In the category of white wines, also, the American varieties yield types of great value. The wines from the *Diana* and *Elvira* are similar to the *Picardans* and the good *Piquepouls.* Home commerce, the manufacture of imitated wines, will find in these productions all the elements of their consumption. I shall add that the wine from the *Cunningham,* which is a red grape, when made white by the separation of stems and pellicles, presents characteristics that render it similar to that furnished by the *Grenache* under the same conditions; and that the analogy may be complete, this wine may be made dry or sweet by arresting fermentation of the must, like the wine of the *Grenache,* in their diverse forms these types are still comparable.

C.—Therefore, it is evident to me, that besides grafting, which will always allow us to obtain our French wines from American stock, the direct cultivation of many American varieties may give wines of veritable value. My observation is founded on the study of four vintages, on the preparation of ninety-five samples[1] fermented at the School of Agriculture, and on the study of more than one hundred other samples coming from various parts of France. The concordance of the results of analysis and testing, and the persistence of characteristics, all authorize my considering that the problem of American wines is solved. I hope that the unfavorable criticism of these wines on the part of persons who as yet have tasted only the wines of the *Concord* and *Isabella,* will finally fall before the teachings of experience.

III. Quantity of Grape Seeds contained in 2.2055 Pounds or one Kilogramme.

Jacques, about	34,200
Herbemont, about	40,900
Cunningham, about	32,000
Wild V. RIPARIA, about	56,800
Solonis, about	18,250
Taylor, about	35.000
V. CALIFORNICA, about	19,600
V. BERLANDIERI, about	26,400

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[1] 1874–1875, 20 samples.
1876, 32 samples.
1877, 43 samples.

95 samples.

IV. Hand Labor Used in Various Work.

VARIOUS NET COSTS.

1. *Tilling Fresh Earth of Medium Consistency.*

By hand, to a depth of twenty inches, from two hundred to two hundred and twenty days' work to the hectare (about two and one half acres).

By hand, to a depth of thirty inches, from three hundred and fifty to three hundred and eighty days' work to the hectare (about two and one-half acres).

With a plow (a single team of six oxen), to a depth of from sixteen to twenty inches, about eight and one half days' work are required per hectare; that is, about 1.19 roods per day.

With a Dombasle plow, followed by a Bonnet subsoiler, to a depth of two feet, it takes seven days to till one hectare.

2. *Cultivation of Vines.*

By hand, first cultivation, twenty-five days' work per hectare.

By hand, second cultivation, twenty days' work per hectare.

By hand, third cultivation, fourteen days' work per hectare.

Tilling with the plow, about four days' work per hectare.

Vine scarifiers and vineyard hoes can do from about one half to two roods per day, according to the size of the implement, the depth of the work, the consistency of the soil, and the horse power.

3. *Grafting.*

A.—Ordinary cleft graft on old vines. (Mr. H. Maré's system.[1])

For one hundred vines:	
Removing the earth from around the vines, at .80 francs per hundred	0.80
Cutting off the stock (500 per day at 3 francs)	0.60
Setting the graft (300 per day at 4 francs)	1.35
Lutation, with grafting clay (600 per day at 1 franc)	0.16
Putting back the earth around the vines (500 per day at 3 francs)	0.60
	3.51
One tenth for stocks to be regrafted the following year	0.35
Total francs	3.86

B.—Ordinary cleft graft on two year old stocks. (Mr. Des Hours' system.)

On two hectares (about 5 acres), 9,700 vines, 8 days' work for gathering and laying by the grafts	14
Removing earth from around the vine, at 0.85 francs per hundred	34
Eighteen days' work of grafting, at 5 francs	90
Thirteen days' work of grafting, at 4 francs	52
Thirty-one days' work of assistants, at 2 francs	63
Twenty-four days' work of women staking, at 0.75 francs	18
Clay for putting on the grafts, etc.	3
Wine, about two pints per day to each grafter, at 0.30 francs	9
Total	383

Say 141.5 francs per hectare, and about 29 francs per thousand vines.

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[1] Le Livre de la Ferme, Vol. II.

C.—English cleft grafting in the workshop on rooted stocks, by means of the Petit machine. (Mme. Ponsot's system.)

Two men with two machines, one cutting the rooted vines, the other grafts.

Two grafters collecting and putting together.

Four women binding, and another selecting, arranging, and transporting.

Say in all, four men and five women can get through with from twenty-five hundred to three thousand grafts a day.

4. Elevation of Water by Machines.

Neut and Dumont's rotary pumps, and Gwyne's, give forth about twenty-six gallons per second, requiring nearly two horse power per metre of elevation.

Those that give a supply of thirteen gallons per second require 1.20 horse power per metre of elevation.

The consumption of coal in the locomotives running these apparatus varies between about five and seven pounds per hour and per horse-power. When coal of inferior quality is used, this amount may be raised to nine pounds, and sometimes more.

V. Gauging the Water.

1. Gauging Streams of Water.

For gauging streams of feeble flow (1 or $2m^3$ per second at the most), the following method is used: A very horizontal dam is constructed, over which the water flows in an even stream, or else a wear sufficient for the passage of the whole volume is made in a dam. We will call the height of the water, below the opening, H; the width of the wear l, and that of the dam L. When l is greater than 0m.09, and less than $\frac{1}{3}$L, and when l H is smaller than the fifth part of the stream just beyond the reservoir, we obtain the flow of water Q by the formula:

$$Q=1.77\ lH\sqrt{H}.$$

When l is equal to L, and H is greater than 0m.06, and less than one fourth the depth of the stream back of the dam, we must use the formula—

$$Q=1.96\ LH\sqrt{H}.$$

When H is greater than one fourth the depth of the water, we use the formula—

$$Q=1.9^2\ LH\sqrt{H\times 0.115\ w^2}.$$

w is the velocity of the current on the surface as it comes into the wear; it is determined by means of a water-gauge.

2. Gauging Canals.

When the streams have a water-way and a regular flow, as is usually the case with canals, they may be gauged with water-gauges.

The superficial velocity indicated by this means, multiplied by one of the following coefficients, gives the mean velocity—

Velocity on the surface, per second.	Coefficient.
$\frac{1}{10}$ metre	0.760
$\frac{1}{2}$ metre	0.786
1 metre	0.812
1½ metre	0.832
2 metres	0.848
2½ metres	0.862
3 metres	0.873
3½ metres	0.883
4 metres	0.891

By multiplying the mean velocity by the water-way of the stream, the required flow is obtained.

3. Quantity of Water Furnished by a Continuous Flow.

A flow per second of—

Pints.		Per Day.	Per Month.
.8803865	gives	42m^3.200	1296m^3.000
1.760773	gives	86m^3.400	2572m^3.890
2.6411595	gives	129m^3.600	3778m^3.008
3.521546	gives	172m^3.800	6184m^3.000

VI. Biology of the Phylloxera.[1]

Phylloxera vastatrix appears in various forms—some subterranean, others aerial. They are: first, the *Agamous aptera* (wingless, aerial, and subterranean); second, the *pupæ* (subterranean); third, *agamous winged insects* (aerial), and the sexual individuals (aerial). It is now no longer contestable as to whether these diverse forms come from the same origin.

First—AGAMOUS APTERA.—The Agamous aptera come from the egg of the sexual individuals. They usually come forth in April in the Mediterranean climate. They are recognized by their agility, by their somewhat grayish pale yellow tint, by the length of their legs and antennæ, and by the stiff hairs covering these organs. According as the atmospheric conditions are more or less favorable to one or the other mode of existence, they crawl up on the canes and leaves, or go down into the ground on the roots.

a. Gall State.—In the first place, the insect, by puncturing, produces on the parenchyma of the young leaves, on the herbaceous canes, which are very tender, or even on the tendrils of certain species and varieties, galls in which it settles itself, and after three successive changes enters the mother state, without there has been the intervention of a male. It then becomes swollen and large, and lays successively in the pouch thus formed a large number of *pseudova* (false eggs, as opposed to the egg of the sexual female). In a short time they are hatched. The young of this second generation, in their turn, settle on the leaves of the extremities and there form galls, or else they descend to the roots. The multiplication of galls, if circumstances are favorable, may be continued until the fall of the leaves.

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[1] For a more complete study, see *Études sur le Phylloxera vastatrix*, by M. Maxime Cornu. *Memoirs Presentés par Divers Savants à l'Académie des Sciences*, Tom. XXVI, No. 1; and *Histoire du Phylloxera*, etc., by J. Lichtenstein: Montpellier, Conlet libr., 1878.

b. Radicola Type.—The insects that penetrate under ground and live on the roots, may be divided into two classes—the one, which like the gallicolæ, pass, by a series of three changes to the mother state; the other, which, after five changes, come to the pupal state.

1. The mothers, very similar to those of the galls, not impregnated, lay from twenty-five to thirty *pseudova*, at the rate of two or three every four or five days, after which they die. The *pseudova* hatch in eight or ten days, and give birth to active young insects able to leave the ground by the crevices in the soil, and, either by crawling or being borne along by the wind, settle on roots farther off. This new generation passes through the same stages, and things continue thus until the end of October or the beginning of November. At this season the mothers die, and the young ones recently hatched pass the Winter on the roots, in a completely torpid condition. They then assume a brown tint and seem emaciated and flattened out. In April these hibernants become active; they then continue the series of agamous generations previously described. It has been found that this mode of multiplication may be continued for three years at the least.

2. The aptera, that do not become mothers, undergo, as we have said, two changes more than the others, and go into the pupal state in July.

Second—PUPÆ.—The pupæ are characterized by being longer and of a more fawn color than the other radicolæ, and by the deep color of the wing cases, which they have on both sides. In fifteen or twenty days, the pupa leaves the ground and acquires wings by another transformation.

Third—AGAMOUS WINGED INSECTS.—The winged insect resembling a very small gnat, has a long yellow body with four transparent wings, longer than the abdomen and of unequal length, the two anterior longer than the posterior. The winged insect takes its flight and is often wafted very far by the winds; that is probably the principal agent in its flying to great distances. When it can stop itself it settles on the under side of the vine leaves, and there, without impregnation, lays from three to six *pseudova*, some large, others small, from which come the sexual individuals.

Fourth—SEXUAL INDIVIDUALS.—The females come from the larger *pseudova* of the winged insects, the males from the small ones. These insects are apterous, without suckers and digestive organs; they mate almost as soon as they are hatched, and the female lays an egg from which, the following Spring, are hatched the new generations of agamous aptera; which were spoken of at first.

This egg, which has been named the winter egg, because where it was first studied (Gironde) it remained unhatched during the Winter, is deposited under the bark of two year old wood (beneath the shoots of the current year). It is hard to be found in the Mediterranean region; possibly, owing to the climatic conditions of that locality, it may there be deposited underground, and sometimes hatched before Winter. We give, in the following table, a summary of the biological cycle of the phylloxera:

From the eggs of the sexual individuals are hatched the young insects, which become—

A.—Some gallicolæ, then radicolæ (always agamous mothers).

B.—Others radicolæ, *a.* some are agamous mothers; *b.* the others become pupæ, then winged insects, which lay the *pseudova*, whence come, 1st (from the little *pseudova*), male sexuals; 2d (from the large *pseudova*), female sexuals, which, after fecundation, lay the initial egg.

VII. Viticultural Calendar.

JANUARY.

Multiplication.—Stratifying the grape seeds in sand; layering, cutting, and putting by grafts and cuttings; grafting in the workshop on cuttings and on rooted stocks, and burying the grafts in sand.

Plantation.—Tilling the soil for planting; setting out rooted vines, in light and dry soil.

Culture.—Pruning (excepting during heavy frosts); removing earth at foot of vines; fertilizing.

Accidents, Parasites, etc.—Scalding, sulphuring, washing for the Pyrale; repeated treatment with bisulphide of carbon (P. L. M. method), or simple application of sulpho-carbonate of potassium (Libourne method), for phylloxera; washing vines attacked with anthracnose with sulphate of iron.

Submersion.—Continuing submersion.

FEBRUARY.

Multiplication.—Continuing layering; cutting and putting aside grafts and cuttings; grafting on cuttings and on rooted stocks in the workshop, and covering the grafts with sand.

Planting.—Tilling; setting out rooted vines.

Culture.—Pruning (excepting during heavy frosts); removing earth at foot of vine; fertilizing; first tilling.

Accidents, Parasites, etc.—Scalding, sulphuring, washing for the Pyrale; continuation of the Winter treatments with bisulphide of carbon and sulpho-carbonate for phylloxera; washing the vines with sulphate of iron for anthracnose.

Submersion.—End of submersions (in the first fortnight).

MARCH.

Vegetation.—During the last of the month, bursting of the buds of *V. Riparia.*

Multiplication.—Dampening the stratified seeds slightly; setting out cuttings; continuing layering; beginning to graft in the open field (second fortnight); grafting on cuttings and rooted stocks in the workshops, and burying the grafts in sand.

Planting.—Setting out rooted vines.

Culture.—Pruning (finishing canes only shortened); removing earth at foot of vines; fertilizing; first cultivation.

APRIL.

Vegetation.—During the first part of the month, bursting of the buds of *V. Vinifera, V. Labrusca, V. Æstivalis.*

Multiplication.—Sowing grape seeds; setting out cuttings; continuing to graft in the open field.

Planting.—Setting out rooted vines and grafts grafted in the workshop.

Culture.—Enjoncage (covering sandy soil with marsh plants, at the end of the month).

Accidents, Parasites, etc.—Preparing for making artificial clouds and looking out for frosts; ridding the vines of Limaçons and Altises by means of the funnel; hunting for the gray caterpillar of the Noctuelle under the ground around the vines, or digging holes for it; transition of the Cochylis to the perfect state; hibernating phylloxera become active, first transformation, laying of eggs and hatching of the first generation of young ones; appearance of galls.

MAY.

Vegetation.—Florescence of *V. Riparia* and *V. Rupestris;* beginning of florescence of *V. Labrusca.*

Multiplication. — Artificial fecundation for the obtainment of hybrids; finishing grafting in the open field.

Planting.—Setting out grafts grafted in the workshop.

Culture.—Second cultivation; first sulphuring; enjoncage (covering with marsh plants) of sandy soil.

Accidents, Parasites, etc.—Continuing to look out for frosts and getting ready to make artificial clouds; appearance of the caterpillar of the Pyrale, and formation of its silken cocoon on the leaves and clusters of fruit; first appearance of caterpillars of the Cochylis; about the fifteenth, disappearance of the grey caterpillar of the Noctuelle.

JUNE.

Vegetation.— Florescence of *V. Vinifera* and *V. Æstivalis* (at the beginning of the month).

Multiplication.—Inspection of grafts for removing roots and suckers; herbaceous layering; artificial fecundation.

Culture.—Third cultivation (after the fifteenth).

Accidents, Parasites, etc.—Stripping off the leaves from the false canes to which the larvæ of the Altise are adhering; appearance on the leaves of the Gribouri in the perfect state; hunting it with chickens or ducks; transition of the Pyrale to the pupal state (at the end of the month); second transformation of the Cochylis; appearance on the ground, in cracked soil, of the young wingless phylloxera; second treatment with bisulphide of carbon (P. L. M. method).

JULY.

Multiplication.—Inspection of grafts for the removal of roots and suckers.

Cultivation.—Third cultivation (until the fifteenth); third sulphuring.

Accidents, Parasites, etc.—Taking precautions to prevent sunburning; transformation of the Pyrale to the perfect state; young wingless phylloxera moving over the ground; appearance of the pupæ of this insect; second treatment with sulpho-carbonate for vines badly attacked.

AUGUST.

Vegetation.—Maturation of *V. Labrusca.*

Multiplication.—Inspection of grafts for the removal of new shoots and suckers; reserving the new shoots on stocks on which the operation has failed in Spring.

Accidents, Parasites, etc.—The Pyrale lays its eggs; second ravages of the Cochylis (premature gathering of grapes, when possible); appearance of the winged phylloxera; young wingless phylloxeras move over the ground.

SEPTEMBER.

Vegetation.—Maturation of *V. Riparia* and most of the *V. Æstivalis.*

Accidents, Parasites, etc.—Hatching of the Pyrale; swarming of winged phylloxeras; young Aptera move over the ground, if the soil is not softened by rains; appearance of the sexual individuals; laying of the eggs.

OCTOBER.

Accidents, Parasites, etc.—Hatching out of the Attelabe; swarming of phylloxera continues during the beginning of the month; sexuals are still found; multiplication begins to diminish in the second fortnight.

NOVEMBER.

Multiplication.—Commencement of layering; planting; plowing.

Submersion.—Commencement of submersion (if the canes are sufficiently ripened).

Accidents, Parasites, etc.—Beginning of the Winter torpor of phylloxera; about the fifteenth there remains only the young ones, which assume a copper color; repeated treatment with bisulphide of carbon (P. L. M. method), or simply the Libourne method, when vegetation is much arrested.

DECEMBER.

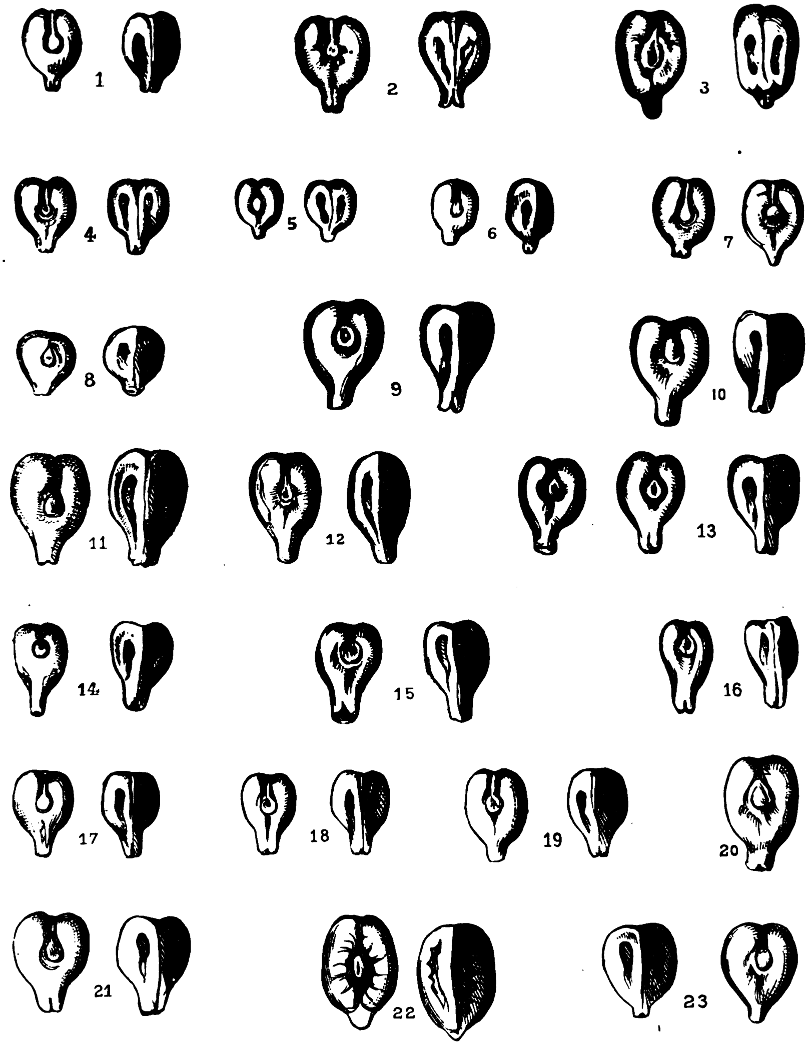
Multiplication.—Stratifying the grape seeds in sand; continuing layering; grafting on cuttings or rooted stocks in the workshop, and burying the grafts in sand.

Planting.—Plowing.

Culture.—Pruning (except when there is frost); removing earth at foot of vines; cartage of fertilizers.

Accidents, Parasites, etc.—Scalding, sulphuring, washing for the Pyrale; Winter treatment with bisulphide of carbon and sulpho-carbonate of potassium for phylloxera.

Submersion.—Continuation of submersion.



SEEDS OF CERTAIN AMERICAN AND EUROPEAN VINES.

1.—V. Æstivalis,
2.—V. Cordifolia,
3.—V. Candicans,
4.—V. Cinerea,
5-7.—V. Riparia,
8.—V. Rupestris,
9.—V. Labrusca,
10.—Isabella,
11.—Taylor,
12.—Clinton,
13.—Delaware,
14.—V. Vinifera,
15.—Chasselas,
16.—Cabernet,
17.—Jacquez,
18.—Herbemont,
19.—Rulander,
20.—Eumelan,
21.—York-Madeira,
22.—Scuppernong,
23.—V. Solonis.

APPENDIX B.

STUDIES

ON

SEVERAL SPECIES OF WILD VINES OF AMERICA,

AND THEIR

Adaptation to the Reconstitution of European Vineyards.

BY

'PROFESSOR M. A. MILLARDET,

Of the Faculty of Sciences of Bordeaux.

[Translated from the French.]

STUDIES

ON

SEVERAL SPECIES OF WILD VINES OF AMERICA,

AND THEIR

Adaptation to the Reconstitution of European Vineyards.[1]

CHAPTER I.

RESISTANCE TO PHYLLOXERA OF SEVERAL WILD SPECIES OF AMERICAN VINES.

We are constantly hearing American vines accused of having brought phylloxera to us; and it must be admitted that the fact, if not positive, is at least probable, although the terrible insect may have been imported to us by some other intermediate agent, vegetable or animal. But it must not be forgotten that these vines, if the cause of the evil, are also the remedy by their extraordinary resistance to the attacks of the insect. I will go further; it is due to their having phylloxera in America that they are able to resist it, and consequently that we can utilize them. A little less excitement and more logic would not hurt anything. Some author asserts that American vines are the ruin of our vineyards, because their being adapted to phylloxera will perpetuate the insect indefinitely among us. It seems to me, on the contrary, that it is impossible to present a better argument in favor of grafting our vines on these plants, if unhappily adapted to the insect. Almost all Europe, from the western frontiers of Russia to the ocean, is at present invaded by phylloxera. Man, it must be admitted, is completely powerless to destroy it. What more fortunate than his finding vines resistant to this devastating insect, and capable of serving as grafting stocks for our varieties, although these vines come, like phylloxera, from America, and even bring us several thousands more of these insects, an insignificant number in comparison to the millions of billions that have established themselves in our midst? Cannot the adversaries of American vines reason as follows: if, on the one hand, phylloxera exists in America, and if, on the other, there are grapevines in that same country, these, by the very fact of their living constantly in the midst of the insect, must be able to resist it. Therefore, if we intend to look somewhere for grafting stocks for our varieties, it is precisely there tha we are most certain of finding them.

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[1] *Études sur quelques espèces de Vignes de l'Amerique due·Nord*, etc., *par* M. A. Millardet, Professor à la Faculté des Sciences de Bordeaux; Bordeaux, chez l'auteur, Boulevard de Caudéran, 190, et chez Feret, Cours de l' Intendance, 15, 1879.

That is not to say that experiments in other directions are to be condemned. Mr. Lavalie[1] recently suggested experimenting with the different species of Asiatic vines with respect to their resistance to phylloxera, with the idea of finding among them grafting stocks enjoying perfect immunity as regards this insect. He also recommends trying certain varieties of *Ampelopsis* to the same end. But if the idea that directs his thoughts to Asia, has any foundation, we are not wrong, on that account, in searching for resistant or indemnified grafting stock in America. There, there are resistant species; theoretically there is no doubt, and experiment proves it. Perhaps there may be absolutely indemnified ones there also. As to vines of other regions, we shall always find ourselves in face of this alternative; they will either be related to *V. Vinifera* (*V. Amurensis* seems to be of this sort) and will in that case be attacked by the insect; or else they will be very different to our vine, and then the grafting of the two plants will meet with poor success or none at all. *V. Rotundifolia* (*Scuppernong*) is found in the latter case. As to the *Ampelopsis*, there can hardly be any hope of even utilizing them, after what we have just seen regarding the *V. Rotundifolia.* Besides trials made in grafting on the *Vigne vierge* (*Ampelopsis hederacea*) have always given negative results.

But absolute immunity, although desirable, is entirely superfluous. For the salvation of European viticulture resisting grafting stocks, although notably attacked by phylloxera, such as those American varieties we have already adopted for the past five years will be sufficient, or grafting stocks that are only slightly, or hardly at all, wounded by the insect, such as *V. Æstivalis* (Michx.), *Riparia* (Michx.), *Cordifolia* (Michx.) and *Cinerea* (Engelmn.), which will be studied in this work.

Every one now knows that a certain number of American varieties have resisted phylloxera in Europe, for twelve years past at least. Since 1874 I have not ceased making these varieties an attentive study. The results of my observations have been given in several works.[2]

I will call to mind that in these divers works I very clearly determined what American varieties have the property of resistance to phylloxera, and what ones are deprived of it. Here, in two words, are my conclusions on that subject:

1. All varieties that appear to descend directly from *V. Riparia* and *Æstivalis* (for example: *Cunningham, Herbemont, Jacquez*) resist phylloxera well. On the contrary, all those that appear to descend directly from *V. Labrusca* (*Isabella, Hartford,* etc.), although resisting the insect longer than our European varieties, end, however, by succumbing to its attacks. Their resistance is limited.
2. Varieties produced by crossing the two first named species should be resistant, whereas those resulting from reciprocal hybridization of *V. Labrusca* and *Vinifera* are not so (*Delaware,* Roger's hybrids in general).
3. When a variety is produced by crossing two or more species, among which are found, on the one hand, *V. Æstivalis* or *V. Riparia,*

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[1] *Bulletin des Séances de la Société d'Agriculture de France,* août 1878.

[2] Especially: *La Question des Vignes Américaines,* 1877, Paris, Masson.—Articles published in the *Journal d'Agriculture Practique,* année 1877, Nos. 33 et 35.

and on the other, *V. Labrusca* or *V. Vinifera*, it is sometimes endowed with, sometimes deprived of the property of the resistance to the insect, according as its roots partake of the characteristics of *V. Æstivalis* and *Riparia*, or of those of *V. Labrusca* and *Vinifera*. Thus the *York-Madeira*, hybrid of *Æstivalis* and *Labrusca*, is completely resistant to phylloxera, whereas European and *Riparia* hybrids are not at all resistant, or only very problematically so.

The property of resistance to phylloxera being hereditary in vines, like the characteristics of their organization, and in an equal degree, its existence in the varieties of *Æstivalis* and *Riparia* seemed to me a sure guaranty of the resistance of *V. Æstivalis* and *Riparia* themselves.

But, what is more, it has always appeared to me that this property must be at its highest power in the wild species; not that cultivation has been able to lessen it in the cultivated varieties, but because the latter are nearly all the result of various crossings in which we can recognize or presume the action of non-resistant species, *V. Labrusca* or *Vinifera*.

These considerations have led me, for a long time past, to study these varieties carefully with respect to their bearing towards phylloxera. As will be seen, the provisions I have just spoken of have been fully realized. *V. Æstivalis* and *Riparia*, prototypes of two distinct groups of resistant varieties, prove themselves much more resistant than the most resistant varieties of either of those groups. Moreover, having had the opportunity of extending these researches to two other wild types of the United States, *V. Cordifolia* (Michx.) and *Cinerea* (Engelmn.), none of whose varieties seem to have been cultivated, I have recognized in them the same quality in the highest degree.

The researches I have spoken of go as far back as the Spring of 1875. They were commenced at the late Mr. Fabre's estate of Saint Clément, in Herault, where I had occasion to graft and plant, in phylloxerated earth, the *V. Cordifolia*, *Riparia*, *Æstivalis*, and *Labrusca*. Since 1876 I have been able to continue this work in Bordeaux. During the Winter of 1876–7, I received from America a lot of seeds of wild vines belonging to the species I have just named, and including, also, the *V. Cinerea*. To this lot I added seeds of the varieties that are most recommendable for their resistance—*Taylor*, *Clinton*, *Solonis*, *Warren*, *Jacquez*, etc. They were planted in about ten-inch pots. Germination almost over with, the young plants were divided into two lots.

One lot remained in the pots. These, about fifty in number, passed the whole of the fine season in the garden, where they received all necessary watering. The other plants, in the last part of June, were taken out of the pots and planted with the earth adhering to their roots in the most murderous part of Mr. Laliman's estate. The total number of young American plants experimented on, in the two lots, was more than four hundred. I had taken care to sow, side by side with the latter, seeds of the *Chasselas* and *Malbec*. Two hundred and fifty germinated, and served as proofs of each series of experiments.

The plants left to themselves, at Mr. Laliman's, were not long in being invaded by the phylloxera. As for the pots I kept in my garden, they were infected, in the last week of May, by means of nodosities covered with the insects. Nearly all the infections took immediately; a very small number had to be repeated after a few weeks. At the end of October, all the plants were dug up with the greatest precaution, and carefully washed in plenty of water. As they were planted in loamy soil, it was easy to disengage their roots without doing the least damage to the latter. I then preserve in alcohol one thirtieth of these plants, which I can affirm lose neither a rootlet nor a node.

In every case, as wèll in the case of plants cultivated in pots as of those I had consigned to the murderous soil of the Touratte, the result was the same. The *Chassèlas* died in the proportion of about one sixth; those that survived, stunted, had their radical systems partly destroyed; nodosities long since decomposed; numerous tuberosities partly rotted.

The *Solonis*, *Warren*, *Jacques*, *Taylor*, and *Clinton* of a very fine aspect externally. The radical system in the last two, and in the *Long* (Laliman) presents numerous nodosities, at least half of which are rotten, and several tuberosities. The roots of the *Solonis* and *Warren*, and part of those of the *Jacques* are found to be in a better condition.[1]

As for the *V. Riparia*, *Æstivalis*, *Cordifolia*, and *Cinerea*, the plants, at first sight, do not seem to be more vigorous than those of the preceding category. But their roots present a totally different aspect. In the *V. Riparia* and *Æstivalis*, the nodosities are rare and scarcely rotted. In the *V. Cordifolia* and *Cinerea*, I have to inspect many plants in order to discover a few almost imperceptible nodosities; tuberosities very rare, or even entirely wanting. These results appeared perfectly conclusive to me. Nevertheless, I wished to see them confirmed by a second experiment. The plants that were not to serve for study were replanted, either in pots or in the open field, at Mr. Laliman's, and subjected anew for one year to the action of phylloxera.

At the end of October, 1878, I made another attentive examination of my plants; it furnished me results in every way identical with those obtained the past year.

The *Chasselas* plants, at Mr. Laliman's only, about twenty in number, are dead, excepting eight, whose roots are in a most wretched condition.

The *Solonis*, *Warren*, *Jacques*, *Long* (Laliman), *Clinton*, and *Taylor* are, in general, in a very good condition, excepting a few of the *Long*, *Jacques*, *Clinton*, and *Taylor*, whose roots show rather serious injuries.

The *V. Riparia*, *Æstivalis*, *Cordifolia*, and *Cinerea*, especially the first and the last two, show remarkable vigor. The radical system is almost intact in the first two; in the *V. Cordifolia* and *Cinerea*, the nodosities are so rare that, at first sight, these plants might be believed to be perfectly free from phylloxera; no tuberosities.

In order not to fatigue the reader with too many details, I will limit myself to this short account of the observations made in

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[1] I will remark, that in this case, the plants I speak of are seedlings, and not cuttings, and that these observations are applicable only with great reservation to the varieties under consideration.

1877 and 1878 on seedlings. For them alone, in fact, they are, taken altogether, perfectly conclusive. Nevertheless I hasten to add that all of the observations I have had the opportunity of making during the past four years, on the wild species under consideration, in divers localities, entirely confirm the results just given.

The resistance of the species I have just spoken of is absolutely certain.

In fact, if there may be any doubts regarding that of certain varieties, whose roots, subjected to the action of the insect, show notable injuries, there are no longer any for the four species that form the subject of this article. They resist and will do so indefinitely, for the simplest and best of all reasons: because their roots are not at all or only insignificantly injured by phylloxera.

In the month of August, 1877[1], I called the attention of viticulturists to one of these plants, the *V. Riparia.* Several months after, it was also recommended as phylloxera proof, but wrongly, by the late Mr. Fabre[2]. Since then it has been cultivated with the greatest success and on a vast scale. The other three species are yet absolutely unknown to viticulturists. It will be necessary, in the following chapters, to reconsider their natural history and the method to be followed in order that they may be advantageously applied to the reconstitution of our European vineyards. We shall see that by their use viticulturists will attain this double result; certain resistance and truly unheard of cheapness of grafting stocks for our European vines.

CHAPTER II.

ESSENTIAL PROPERTIES OF THE PRINCIPAL SPECIES OF AMERICAN VINES RESISTANT TO PHYLLOXERA.

The *V. Riparia* (river-bank grape of the Americans) has wood of average thickness and solidity. It takes root by cuttings with almost the same facility as our European vine, if not better; seventy-nine out of one hundred cuttings from America have taken root. The grafting of this vine on French stocks always succeeds, that is, in a proportion of ninety per cent. *V. Riparia* is already used in Languedoc as grafting stock for our European varieties, with the greatest success. English cleft grafts, on simple canes, usually thrive in a proportion of from fifty-five to sixty per cent.; on rooted stocks the result is much more satisfactory (ninety to ninety-five per cent).

As I was the first to declare, in 1877[3], the *V. Riparia* is the best grafting stock at present known. It is already much propagated in the South and in Bordelais, and each Spring augments, by many hundreds of thousands, the number of canes that are grafted or set out in the nursery. It has been found that it adapts itself to the worst soils, and that it dislikes neither arid pebbly land nor strong soil. In America it grows in rocky places along streams of water.

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[1] See No. 35 of the *Journal d' Agriculture Pratique,* année 1877.

[2] No. 48 of the same journal, same year.

[3] *Journal d'Agriculture Pratique,* 1877, No. 35.

It is so little attacked by phylloxera that Mr. Fabre believed it completely indemnified.[1] I have proved the falsity of this opinion.[2]

All the plants of this species now cultivated in France seem to come from the vicinity of St. Louis, Missouri; they are far from being identical; we easily distinguish throughout them, two series of forms very distinct in their most extreme characteristics but blended together by intermediary characteristics without number. One is characterized by almost glabrous leaves, the other by leaves very pubescent, especially on the under side. To the first series belong, first, the *Michaux* types; second, a certain number of hybrid forms of *V. Cordifolia* and *Riparia*; third, a type somewhat related to the latter but produced by crossing with *V. Rupestris.* The hybrids of *Cordifolia* and *Riparia* are recognized by the considerable elongation of the median lobe of the leaf, and by the relative smallness of the lateral lobes, and also by the general subcordate form of the leaf. *Riparia* hybrids of *Rupestris* are most especially characterized by the very broad leaf, brittle, smooth, and the extremity bent over backwards, that is to say, on the under side of the leaf. The leaf-stalk indentation is larger than in the other forms. The wood of these plants appears also to be much harder than that of the type in general. The nodes are nearer together. Rooting by cuttings is not so easy. The seed is large, with short beak. The fruit is sweetish, not acid; the bunch small.[3]

The second series of *Riparia* take in, as we have said, the pubescent forms. Some, the most common in collections, appear to me to be hybrids of *V. Riparia* and *V. Cinerea.* In fact, like this last species, they have the new wood covered with a thick velvety down. Probably the *V. Cordifolia* and *Rupestris* may also be included in the production of these downy forms of *Riparia,* but at present I do not know of any sure example. Finally, I had the opportunity of seeing, in the Soyer-Villemet herbarium, a hybrid of *Riparia* and *Æstivalis* with remarkably downy leaves, coming from St. Louis, as do all the forms under consideration.[4]

These indications will suffice to show what a really incredible number of forms of vines belonging to the species *Riparia* the collector may meet with in a given place in Missouri. All of these forms are far from having exactly the same properties; for example, they take root more or less easily by cuttings, according to their more or less close relationship to *Riparia.* But all are extremely resistant to phylloxera, since all the species we have spoken of, and which enter, in a greater or less degree, in their constitution, have the property of resistance to the insect in the highest degree.[5] However, it would seem that in the downy form the resistance was more marked (Dr. Despetis). This fact would be a confirmation of my observations on the so remarkable resistance of *V. Cinerea.*

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[1] *Journal d'Agriculture Pratique,* 1877, t. II, p. 586.

[2] Same collection, 1877, t. II, p. 716; 1878, t. I, p. 269.

[3] From recent researches on this subject, not yet published, I believe that the variety called *Solonis,* and probably the *Pedroni* also, should be included in this group of hybrids. The detailed account of the reasons on which I base this opinion will be given later; meanwhile, the preceding indications will suffice for competent persons.

[4] We are indebted to M. Victor Ganzin (*Vigne Américaine,* 1879), and to M. le Dr. Davin (Id.) for two attempts at classifying the forms, so diverse, of *V. Riparia.*

[5] See the preceding chapter for information on the resistance of *V. Riparia, Cordifolia, Æstivalis,* and *Cinerea.* As for *V. Rupestris,* it is only a very short time since I have been able to form an opinion on its resistance to phylloxera. I made only one personal observation on this matter —last October—in a phylloxerated vineyard in Bordelais, but it is confirmed by a similar observation of M. Gazin, Vice-President of *Comice Agricole de Toulon,* whose sagacity is well

Thus all the forms of *V. Riparia* under consideration—that is those met with in Missouri—may be used with advantage as grafting-stocks, upon one essential condition however, that is that they are not mixed with *V. Labrusca,* the only vine now known in the United States that does not resist phylloxera well. Happily it is found that the *V. Labrusca* has a very limited area of distribution, and that it is entirely absent from the whole basin of the Mississippi (G. Engelmann). In the most northern parts of this basin, at St. Anthony Falls and Lake Superior, *V. Riparia* alone exists, to the exclusion of every other species of grapevine (Idem, in Litt). It is the same in Canada, so that it would be possible to obtain this vine absolutely free from all mixture, if that would be advantageous. Perhaps it would be of real advantage, the *V. Riparia* bearing in the north larger berries and seeds than in the south, at least according to the information furnished me by Dr. Engelmann, who must always be quoted.

V. Cordifolia, called Frost grape, Chicken and Winter grape, in its native country is the most vigorous of the species to be considered in this study. While the others seldom grow higher than the shrubs, we see the latter reach the summit of the highest trees. Its area of distribution is about as vast as that of *V. Riparia,* it extends not so far north and east, but farther south than the latter species. In the central part of the United States both are found, a fact that explains how it is we find, among Mr. Bush's shipments, a small number of individuals of this species mixed with *V. Riparia.*

The species we are speaking of has stronger wood than the *V. Riparia,* which is a notable advantage. Grafting it on French stocks succeeds perfectly. (I have succeeded each time in three graftings.) It does not root at all well by cuttings. Notwithstanding repeated trials, one after another for three years, on a dozen canes each time, it has been impossible for me to obtain a single rooted vine in propagating by cuttings in the open field. Mr. Caille, head-gardener at the *Jardin des Plantes,* at Bordeaux, out of eighteen cuttings, in a hot bed, had one that took root. In grafting our European varieties on the species in question, it will be well to use the same precautions as in the case of the *V. Æstivalis,* that is to graft only on rooted stocks in the open field.

V. Cordifolia seems more variable, but it has without doubt, like its congeners, produced a great number of hybrids by crossing with the other wild species of the North American forests. Indeed, I have already stated that we frequently find, in collections and nurseries, side by side with the typical form, individuals that appear intermediary between this and the *V. Riparia.* Up to the present time, I have

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known by amateurs in American vines. He wrote me, November 15th: "My *V. Rupestris* are nourished by *Clintons* five years old, and very phylloxerated; their roots are therefore developed in the immediate neighborhood of phylloxera. Under these conditions, two roots, which I extracted carefully, with their beard and fibrils, have not shown, under the magnifying glass, a single nodosity. I must say that the roots of *V. Riparia* put forth, under identical conditions, have shown me only very rare and imperceptible nodosities."

not met with any product of the crossing of this species with other native species growing in the same place, in Missouri, excepting it may be the form called *Coriacea*, by Dr. Davin. From a yet very incomplete study, it seems probable to me that this plant owes its origin to the crossing of *V. Cordifolia* and *Candicans*, in which, perhaps, *V. Cinerea* and *Rupestris*, also, are mixed. This multiplicity of origin may appear singular, even to botanists. Until I can prove it by analyses and the necessary outlines, I shall simply call upon Wichura to prove the existence, in willows, of infinitely more complex crossings than those I have ascertained, up to the present time, in American vines.

All these vines, without doubt, make excellent grafting stocks, aside from the greater or less difficulty in propagating them by cuttings; but we shall soon see the means of correcting this fault.

As to its resistance to phylloxera, the type *V. Cordifolia*, it seems to me, should be placed in the first rank with *V. Cinerea*. The experiments I have given precedingly show, in fact, that these two vines, with the *V. Rotundifolia*,[1] are the most refractory to the insect of all the American species now known.[2] As for the hybrid forms coming from Missouri, their resistance must be estimated according to the same rule used in estimating that of the hybrids of *V. Riparia*; that is, that since, owing to the absence of *V. Labrusca* in this region, all the crossings have been between resistant vines only, the products of the latter cannot be other than wholly resistant.

It is in the rich and deep alluvium of streams of water that the *V. Cordifolia* grows. It will come to be, with the *V. Cinerea*, the natural grafting stock of our marshes, and of lands of analogous constitution. There is no doubt that it communicates great vigor to the European varieties, which are nourished by its powerful roots. Therefore, it seems that our most vigorous varieties should be grafted on it in preference. According to that, it will be necessary to take into account, when spacing the stocks, the increase in vigor that this species will be able to give to our European vines.

While the *V. Riparia* goes as far as sixty miles north of Quebec, the *V. Cordifolia* is a plant of the average and low latitudes of the United States. However, although it dislikes cold much more than the former, it will be able, owing to the enormous differences existing between the climate of these regions and that of Europe, to serve as grafting-stock for our European vine wherever the latter is now cultivated.

The *V. Æstivalis* (Summer grape) has strong and hard wood. According to my experience, it will not take root by cuttings, even in a hot-bed. I succeeded with one graft out of three, on French stock. Mr. Laliman has many a time grafted, successfully, divers French varieties on an old vine of this species, perhaps a hybrid. However, the success met with in grafting our French varieties on varieties of *Æstivalis* is a certain guaranty of the possibility of performing the same operation on the wild type. But it is necessary, as I have already remarked, to graft, not on a simple cutting, but on a rooted stock in the open field.[1]

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[1] Up to the present time not one attempt at grafting our European vine on *V. Rotundifolia* has been followed with success.

[2] According to my experience, phylloxera very easily causes numerous nodosities on the roots of the *Mustang* (*V. Candicans*).

Mr. Bush remarked, repeatedly, in his catalogue, that the varieties of *Æstivalis* have, in general, the property of growing in arid soils and of defying the most extreme dryness of climate. The *Warren* and *Jacquez* especially are remarkable in this respect; therefore the latter, abandoned by viticulturists in regions of the southern part of the United States having a moist atmosphere, takes refuge in Texas, where it thrives, notwithstanding the excessive aridity of the soil and climate. It even seems that this dryness is the first condition of health in its case, a fact that protects it from two great enemies of the vine in America, anthracnose or *carie noire* and mildew. Other cultivated varieties of *Æstivalis*, while preferring the warm climates in the southern part of the United States, require, in order to prosper, a more humid soil and atmosphere. The *Norton's Virginia* and *Cynthiana* are of this class.[2] As to the species itself, it is different in this respect from the last named varieties, being more closely allied to the *Jacquez*. It inhabits the middle and southern regions of the United States, where it is found oftenest "on plateaus, in dry places, covering the bushes or shrubs of the glades."—(Engelmann.)

The properties we have just enumerated render the *V. Æstivalis* a grafting stock particularly adapted to the Mediterranean region, and to the *garrigues* and *aspres* of Provence, of Languedoc, and of Roussillon. Up to the present time its cultivation has not been attempted. It is found here and there in collections, but unknown. The impossibility of multiplying it otherwise than by seeds or layers has doubtless kept persons who possess it from giving it the attention it deserves. It would be extremely desirable to possess the hybrid form of *Æstivalis* and *Riparia* which I have mentioned. Its resistance to phylloxera must equal that of both its parents, but it certainly has the advantage over the *V. Æstivalis* in taking root by cuttings, and over the *V. Riparia*, in requiring less moisture in the soil and atmosphere.

Mr. Engelmann considers the *V. Lincecumii*, or post-oak grape, which grows in the sand in Texas and Louisiana, a variety of *V. Æstivalis*. This vine is evidently adapted to aridity of soil and climate, but all that is known of its resistance to phylloxera is what analogy permits of supposing, from its close relationship to *V. Æstivalis*, and from its inhabiting phylloxerated regions. The author I have just named also connects with the species *Æstivalis* the *V. Monticola* (Buckley), a plant of the same region as the preceding, and of which but very little is known.

We have seen precedingly that as for resistance to phylloxera, the *V. Æstivalis* is about on a parallel with the *V. Cordifolia*, *Riparia*, and *Cinerea*. I will add that Mr. Laliman has a very old vine of this species that has seen an entire French and even American (*Labrusca*) vineyard perish around it, without ceasing to show the most luxuriant vegetation.

The last species we have to study is *V. Cinerea*. This plant is yet very little known. Mr. Englemann allies it to the *V. Æstivalis*, of which it would be only a variety. It appears to me distinct; however, I do not wish to give a definite opinion, yet, one way or the other. *V. Cinerea* is easily recognized by its almost entire leaves, velvety and ash-colored underneath. The young wood, especially during infancy, is polygonous, and covered with very thick grayish down, consisting of short awl-shaped hairs. At maturity, the wood is of a very light gray.

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[1] In the *Question des Vignes Américaines*, p. 42.

[2] On this subject see G. Bourgade, *Adaptation parfaite des Vignes Américaines*, etc. I will remark that it is far from being certain that the two varieties under consideration are direct descendants of *V. Æstivalis*.

This plant grows very large. It is frequent in flats and on lakeshores in Missouri and the neighboring States (Engelmann). It has recently been introduced among us, in small quantity, with *V. Riparia*, in Mr. Bush's shipments. I have seen a small number of exemplary grafts of this species on European varieties at Mme. Ponsot's, at Pomerol, near Libourne. In the nursery there are also some rooted vines, one year old, confounded with the downy varieties of *V. Riparia*. This double observation, on the one hand, authorizes me to affirm the possibility of uniting, by grafting, the *V. Cinerea* and the European vine, while, on the other hand, it permits of hoping that, contrarily to *V. Æstivalis* and *Cordifolia*, the plant we are speaking of, may be propagated by cuttings. If this multiplication was easily effected, *V. Cinerea* and *V. Riparia* would constitute the two best grafting stocks now known. We have seen, in the preceding article, in fact, that the resistance of *V. Cinerea* almost amounts to immunity. That conclusion was drawn from my observations of seedlings and exemplary grafted stocks, cultivated in phylloxerated soil.

While the fruit of the *V. Cordifolia* has a more or less tart and nauseous flavor, that of *V. Cinerea*, as also of *V. Æstivalis*, has a very sweet, agreeable taste. If some people fear the influence of the stock on the taste of the fruit of the graft, it will be easy for them to preclude this inconvenience by cultivating only the *V. Cinerea* to the exclusion of *V. Cordifolia*. As to *V. Riparia*, its fruit is only harsh and slightly aromatic.

Farther on (Chapter V) will be found ample details on the last point.

CHAPTER III.

MULTIPLICATION OF WILD VINES BY SEEDS.

The reconstitution of European vineyards by means of grafting our varieties on resistant American stocks, is not only possible theoretically but has become a fact through experience. There exists in many places, and I myself have seen in several localities in Labournais and Languedoc, vineyards of variable extent constituted according to this method, come to their third year and already bearing fruit. Their truly splendid vegetation notwithstanding phylloxera as well as the good condition of the roots, were of a nature to give the greatest confidence in their future prosperity; furthermore, I have heard experienced viticulturists maintain that before the invasion of the plague their vines were less vigorous than those under consideration.

Notwithstanding these results, so remarkable and so encouraging, it must be admitted that the grafting of our European varieties on resistant vines, has not yet been adopted in practical use as it could or should be; that is due to several causes.

In the first place, it is necessary to speak of the deception arising in the case of some varieties at first regarded as resistant from the simple fact that they are vigorous and generally thrive in the United States. I wish to speak of the *Concord*, *Clinton*, and *Taylor*. As for the first, two years of cultivation have sufficed to show that this variety, like all the *Labrusca*, to which it is very closely allied, if indeed it is not a pure *Labrusca*, nine times out of ten is incapable of a somewhat lasting resistance. As for the *Clinton* and *Taylor*, their relationship with this same *V. Labrusca* should have inspired, as I have advised for the past two years,[1] greater prudence in their use. They are planted to some extent everywhere; and experience has proved that if these varieties do resist perfectly in rich, deep, light, and somewhat fresh soil, they succumb to the insect when the climate is too dry, and the soil compact or arid.[2] People have wished to descry in these failures the effect of the action of the soil and climate only; but precise facts prove that phylloxera plays the most important role in these phenomena. Mr. Planchon, who has long upheld on his own authority the varieties which I have just spoken of, is, I believe, now ready enough to admit that all three, generally vigorous and prosperous in the United States, in France show great sensibility to the insect. Whatever may be his opinion on this subject, I assert, that in the poor soil of Herault and Var, and in presence of phylloxera, the *Clinton* and *Taylor* often show but à paltry and stunted vegetation during the first years, and then disappear more or less rapidly, according to circumstances.

It is natural that these checks have set the public against American varieties. But would it not be childish and unfair to condemn a whole system on account of a few partial failures? The resistance of American varieties is so complex a question that it is not astonishing that there are many different schools of thought concerning them. The most experienced viticulturists are forming them all the time without going beyond the plants of their own region. The essential point is to derive from errors once committed the information they convey. In the question with which we are now occupied in particular, it will be necessary, as I have long since recommended, to use the greatest circumspection when planting cultivated or wild vines showing relationship, even the most distant, with the *V. Labrusca* and *Vinifera*. On the contrary, when plants belonging to the species *Riparia*, *Cordifolia*, *Æstivalis*, and *Cinerea* are free from all mixture with the two non-resistant species mentioned precedingly, we may be certain of their resistance.[3]

Another inconvenience that some of the American vines present, and which is keenly felt by viticulturists, is the great difficulty met with in multiplying, otherwise than by layering, many of the most estimable and resistant among them. The varieties of *Æstivalis* are of this class. One result of this fault is the necessity, when we wish to graft our European varieties on these vines, of doing it on rooted stocks, and as far as possible in the open field. We saw, in the preceding chapter, that the *V. Æstivalis* and *Cordifolia*, perhaps *V. Cinerea* also, suffer from this same fault, and to such an extent that it would be absolutely useless to essay propagating them by cuttings.

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[1] In the *Question des Vignes Américaines*, p. 26.

[2] I received recently from M. le docteur Davin, *Taylors* two years old, so badly affected by phylloxera that their death was certainly imminent.

[3] It is doubtless owing to a misunderstanding that Mr. Pellicot has asserted that the *V. Riparia* is seriously affected by the insect.

There must be mentioned yet, among the great disadvantages presented in the use of American vines, the sometimes excessive price of grafting stocks or varieties cultivated for the sake of their fruit. For *V. Riparia*, for example, the *York-Madeira*, *Solonis*, *Touratte*, etc., the price of a thousand cuttings varies from forty to sixty dollars. The *Norton's Virginia*, *Herbemont*, *Cunningham*, and *Jacquez*, especially, are still higher in price. True, by propagating the plants I have just spoken of by means of grafting them on European stock, after one or two years the expense is notably diminished. But then there is waste of time, which also deserves consideration.

After the costs of acquisition, it is furthermore necessary to speak of those of grafting, not forgetting the difficulty of that operation.

As for this last question, it must be admitted that an intelligent vine dresser can, in one season, become sufficiently qualified to merit confidence. First ideas will be given him by a gardener or fellow-grafter. The net cost of each graft executed without a special instrument[1] must apparently vary between one and one and one half cents. This expense may be reduced three quarters by using a grafting machine. Furthermore, it must not be forgotten that the cost of this principal work will be less, in reality, than it seems to be at first; in fact, it is certain that the number of stocks now cultivated per hectare will be notably reduced, owing to the greater vigor of vines grafted on American stocks.

The preceding considerations show forth the weak side of the system. I have already answered, a little farther back, persons who deny resistance to phylloxera on account of a few partial failures. As for the expense necessitated by grafting, and the difficulties of this operation, they have been estimated already. There remains for me to resume the consideration of the difficulty of multiplying certain vines in this way, and of the disadvantage arising from the high price of good grafting stocks. I ask the reader's permission to call to mind that I have already considered this question in 1878.

> Among resistant vines, said I, is found the type *V. Æstivalis.* The experiments I have begun to make will soon tell all that is necessary regarding the resistance of *V. Riparia* and *Cordifolia.* Now, the American forests, from Florida to Canada, are full of these vines. Their value, in the wild state, is almost nothing in their native place; in France, their price would depend solely on the cost of hand-labor and transportation. But there is something still better, in fact it appears certain to me that it will be possible to utilize, for furnishing resisting grafting stocks, not only the seeds of wild species (*V. Æstivalis, Riparia, Cordifolia*), but also those of the most resistant varieties. By this method, the price of the grafting stock will become almost nothing, and the danger of introducing phylloxera in a non-infected country will vanish completely.
>
> I propose to resume the consideration of this important question as soon as my seedlings have furnished positive results.[2]

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[1] Several instruments, more or less complicated and convenient, have recently been invented, destined to shorten the time necessary in grafting, and to render it practicable to persons of ordinary skill. The grafting knife, invented by M. Petit, engineer at Passac (Gironde), is the best one that I know of now.

[2] *Études sur les Vignes d' Origina Amèricaine qui Resistent au Phylloxera*, p. 45, Paris: Gauthier, Villars.

In 1876[1] and 1877, after having studied the resistant varieties with all possible care, and having found the true nature, often so complex, of many of them,[2] I again declared my hope of obtaining, by means of the seeds of some of these varieties, resistant grafting stocks. I pointed out, as qualified for this purpose, the varieties that seemed to me to descend directly from *V. Æstivalis* and *Riparia*, wholly rejecting the hybrids, such as *York-Madeira*, *Touratte*, *Taylor*, etc.

I must say that the question as to the advantage that may be derived from using seeds of the varieties I then recommended, appears to me as still far from being solved. In the first place, it would be necessary, in order that observations made on this subject should have all the value desirable, to be certain of having seeds from which all danger of hybridization is completely excluded. Now, possessors of American vines know how difficult it is at present to satisfy this condition. Notwithstanding that, and although I have not been able to protect myself with entire certainty from this cause of error, and although, consequently, the observations I have had the opportunity of making cannot be regarded as wholly conclusive, I must say, however, that they have considerably modified my opinions. The great variableness I observed in certain varieties that I believed came directly from a resistant species, for example the *Jacquez*,[3] inspired me with doubts as to the exactitude of my conclusions on the subject of the genealogy of some of them. Therefore, I now think that of the varieties pointed out for their resistance for the last ten years by Mr. Laliman, not one is a direct descendant of either *V. Æstivalis* or *V. Riparia.* That being the case, it is not astonishing that certain seedlings of these varieties, from the first generation partially returning to the non-resistant foreign type which, besides *V. Æstivalis and Riparia,* enters in their composition, are less resistant than the vines from which the seeds were derived.

In *La Question des Vignes d'Origine Américaine* I expressed the fear that we might not be able to procure grafting stocks from seeds of wild vines, owing to the enormous number of hybrid forms that grow promiscuously with the typical species in American forests. Since the publication of this work, the experiments I had the opportunity of making in 1877 and 1878, with seeds of wild vines, and of which I have already given an account, as well as other facts, have caused me to change my opinion on this point, and to give the preference to seeds of wild vines, rather than to those of cultivated vines.

The best confirmation of the possibility of obtaining seeds from specific wild types is, that I have, in fact, received some for two years successively; thanks, it is true, to the obliging agency of Dr. Englemann. The fruit is easier to characterize than the leaves or canes: and the collectors of seeds, once instructed as to what they are to gather, will hardly err. These typical species through their constancy are distinct from the variations of hybrid forms. Moreover, each of them has a special period of maturity. Thus, in St. Louis, Missouri, *V. Riparia* ripens the first week in August, or even at the end of July, in precocious years; *V. Æstivalis* at the end of September, and *V. Cordifolia* in October. Farther on will be found the characteristics by the aid of which it is possible to recognize with certainty the seeds and fruit of all these vines.

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[1] In the *Question des Vignes d'Origine Américaine,* etc., p. 31, etc.

[2] Especially in a *Memoir* presented to the Institute, which has not been published.

[1] This variety is one of those whose seedlings show the greatest variableness. I have seen some of the latter, thirty of which were from five to six years old, obtained by the late Durien of Maisonneuve. The great majority showed more or less evident analogies with our European vine. The *Warren* seems to reproduce its type much more faithfully. I have observed bad nodosities and tuberosities on several *Jacquez* seedlings, but especially on the Long (Laliman) seedling. As for the latter vine, my observations are confirmed by oral communications from Mr. Laliman.

But the chief reason for my mistrusting the seeds of wild vines is the fear of hybridization of these seeds by the non-resistant *V. Labrusca.* Now, it appears very positive from Dr. Englemann's researches on this subject, that *V. Labrusca* is foreign to the whole basin of the Mississippi. It is on that account doubtless that I have never met with the *Labrusca* from among the hundreds of thousands of cuttings sent from St. Louis by Messrs. Bush & Meissner; neither do I know of any one who has. The seeds coming from this region, supposing that they are not entirely free from crossing, which evidently is often the case, cannot therefore be hybridized by other vines than the same resistant species we have already considered, and which, with the *V. Rupestris*, also resistant, constitute the only vines of this region. In other words, the cuttings of *V. Æstivalis, Cinerea, Riparia*, and *Cordifolia* coming from Missouri are, without exception, resistant; there is not a doubt that the seeds of these same vines will produce individuals endowed with an equal resistance.

The preceding developments establish, if I am not mistaken, the possibility of obtaining grafting stocks of assured resistance by means of seeds of wild vines, natives of the Mississippi Valley. This new process offers two great advantages, which will make up for the two most important desiderata previously pointed out in the method of reconstituting our European vineyards by grafting our varieties on resistant vines. By these, I mean the high price of grafting stocks, and the difficulty, the impossibility even, in the case of some types, in multiplying the latter otherwise than by layering.

On the one hand, in fact, experience has proved, as will be seen from the following chapter, that the seeds of all the vines considered in this work germinate with us in the open ground with great facility. As, on the other hand, it is possible to procure at a maximum price of about fifty cents a pound authentic unfermented fruit of the species so often mentioned coming from Missouri, I do not think there is anything further to be desired, either under the head of cheapness or facility of multiplication[1] of American grafting stocks.

I will add, in order to render each process its due, that, if propagation by seeds offers considerable advantages over that by cuttings and layering, it is inferior to those processes of multiplication with respect to rapidity of execution, so that part of what is gained in number of vines is lost in time. But this loss is quite limited. In fact, I am sure, from seedlings grown in Franche-Comté, that, after the third year, half the young plants are at the junction of the root and stock from one third to two fifths of an inch thick. In a warmer climate they would be larger. Eminent viticulturists, to whom I have communicated some of my ideas, think it will be possible, in general, to graft seedlings after the second year.

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[1] Since several persons have applied to me with respect to procuring seeds of wild vines, I have begged Dr. Engelmann, whose occupations do not permit his superintending the collecting of these seeds himself, to tell me of a collector at once conscientious and capable. The references given me by Mr. Engelmann authorize me to recommend to my readers, Mr. Henry Eggert, 918 Wash. street, St. Louis, Missouri, already known in the botannical world by his fine collections of American plants. Mr. Eggert engages to furnish authentic seeds, in good condition, of all the species of vines mentioned above, at a price varying from two dollars to two dollars and fifty cents per pound according to the quantity ordered. The cost of sending will be charged to the person they are sent to. Orders will have to be sent in before July first. Small orders of about forty pounds, may be sent in to M. Catros Gerand, Horticulteur Pepinieriste, 25 allées de Tournay, à Bordeaux, who is connected with Mr. Eggert.

There remains for me yet to indicate the method of grafting that it seems will succeed best in the particular case we are considering.

It is important that the grafting of our varieties on resistant stock be done underground, at a depth of about four inches, so that the vinedresser can every year, when removing the earth from the foot of the vine, cut off the roots that would have developed on the European graft. As, on the other hand, it is necessary that the roots of the vine be situated at a certain depth which varies with the soil and climate, the grafting must be done, not at the junction of the root and stock of the young resistant vine, but on the stock at eight or ten inches above the top roots. To satisfy this condition, I will advise from the first year of vegetation, but especially during the second and third, pruning the young plants and keeping an eye on the growth, so as to prevent the stock from branching out below the point where it is to be grafted.

The grafting that it seems to me should be preferred is at the same time the simplest and easiest of all. There is made on one side of the grafting stock, at about one half or four fifths of an inch below a bud, and on the opposite side from the latter, an oblique incision about an inch and a half long which just touches the pith of the grafting stock. In this cleft is inserted the graft, cut wedge-shape so as to fit the incision. The two canes must be bound together.[1] After the graft has taken, the top bud of the grafting stock will be cut off, and the pruning of the latter regulated.

It will be well to take the grafting stocks from the nursery after the second year and set them out in the open field. Later the really incredible development attained by the roots renders the digging up of the plants extremely laborious for the workman, and dangerous for the grafting-stock, which risks being badly mutilated.

CHAPTER IV.

INSTRUCTIONS FOR PROPAGATING VINES BY SEEDS.

Propagating vines by seeds is not a customary operation and a great many persons who wish to attempt doing it often give up, only embarrassed by it, therefore it appears best to me not to terminate this study without adding a few words on this point; I will do so briefly, simply recapitulating a work I have previously published on this subject.[1]

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[1] Mr. Martineau, of Floriac, near Bordeaux, has recently suggested this graft under the name of *greffe géminée*. It yields good results. If the graft does not take, which seldom happens, it offers this advantage: that the stock preserves all its vitality and may be grafted a second time. Mr. Martineau advises leaving two buds on the graft, and two on the stock above the incision. See on this subject L. Martineau, *La Reconstitution des Vignobles au moyen des Vignes Américaines*. Bordeaux, 1878, pp. 13 and 15.

All seeds of the American wild vines we have been considering, as those of the European vine also, germinate perfectly in the open ground in our climate. I have experimented with them in Bordeaux, in 1877 and 1878, and also in Franche-Comté in 1875. Notwithstanding this general facility of germination, there are a few distinctions to be made. It must not be forgotten, for instance, that if the *V. Riparia* is a plant of ranker growth than our European vine, the *V. Æstivalis* and *Cinerea* are very much more sensitive to cold than the latter, so, when the Spring is cold or very rainy, the *V. Riparia* and its derivatives (*Clinton, Taylor, Solonis*), alone spring up from the earth. That was my experience in Bordeaux, in 1877. In a series of observations on this subject, I have seen the germination of seeds of the three species, *Æstivalis, Cinerea*, and *Cordifolia*, prove completely abortive in the open ground, in my garden, while those same seeds germinated very well in pots also placed in the garden in the open air, but protected from rain and nocturnal radiation by a board shelter. The results were identical in another trial in this line made at the same time, in the open field, a little more than a mile from the city; here also the *Riparia* alone came up, the germination of *Cordifolia, Æstivalis, Cinerea, Jacques*, etc., failed completely; therefore I advise, if the Spring is cold, protecting the rows of *Æstivalis* and *Cinerea* by a little manure or dead leaves.

The germination of the *Riparia* type is the most prompt and certain. Then come in order of decreasing rapidity, the types *Cordifolia, Labrusca, Vinifera, Cinerea*, and *Æstivalis*. The germination of *Vinifera* in the open air, and in the climate of Bordeaux (April and May), takes place the seventh or eleventh week from the time the seeds are sown. In the case of *Riparia*, this period is two or three weeks shorter.

The number of young plants produced by American seeds sown in the open field, even when they come from hybrid forms, is somewhat greater than that obtained from European seeds. It may be estimated at two thirds of the total number of seeds put in the ground.

It is important to take into account, as to when the seeds should be sown, the time of the latest frosts observed in the place. By sowing just one month before this time, there will be no danger of the young plants being killed off by Spring frost. Generally, the second week of April seems to me to be the most favorable time for proceeding with this operation.

Two year old seeds germinate in a much smaller proportion than those of the current year. Probably beyond that age they do not germinate in sufficient quantity to give a remunerative result.

The seeds may not germinate for three and four months, or even until the next year, as has twice been my experience. This seems to be due, in a very great degree, to the dry state of the seed, and to the lack of moisture or heat in the soil during the months of April and May. To obtain more regular germination, it will be well to first stratify the seeds in damp sand, as recommended by Mr. Foëx.[1] I simply immerse them in water from three to eight days.

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[1] In the *Vigne Américaine*, No. du 15 Mai, 1878.

It is proved that seeds that have fermented can germinate, but that is not generally the case. The alcoholic quality of the wine, and the length of time that the seeds are in contact with it, probably have an influence on the preservation of the germinative faculty.

The soil, well manured, should be mellowed with care and as deeply as possible. Drills are made in it, as in the case of sowing peas. The seeds are sown about four inches apart in the row; they are covered with a little over an inch of mold.

It is possible to transplant the young vines, taking the precaution to do it in dull, rainy weather, or to protect them from too strong light by a shelter. Mr. P. Petit, Secretary of the *Société d' Agriculture de l'Indre*, writes me that he transplants successfully, with or without the earth adhering to the roots, during the first days of germination, before the cotyledons are spread apart.

During the first year, it is well for the young plants to be at least four inches apart in the row. During the second year, twice that distance will be necessary if we wish them to acquire all their development. The distance between the rows can hardly be less than ten or twelve inches.

Finally, I will call to mind, in closing, that it is important, during the first two years, to watch the development of the plant with the greatest care, so as to prevent branching below the point where the graft is to be applied. This precaution is to compel the young stock to acquire all the development possible in thickness, up to a height of ten or twelve inches, so that it is capable of adapting itself perfectly to the wood of the graft.

CHAPTER V.

CHARACTERISTICS BY WHICH WE MAY RECOGNIZE THE SEEDS OF THE PRINCIPAL SPECIES OF NATIVE VINES OF NORTH AMERICA.

In commerce, seeds of American vines are found in two different conditions—some are absolutely naked, stripped of the pulp and skin of the fruit; the others are still inclosed in the berry. I have had occasion to sow both kinds; the results were the same in each case. American collectors dry the seeds carefully in the open air. As for the fruit, it is apparently exposed to the sun until it has lost such a quantity of water that its fermentation is no longer to be feared. Simply packing them in a wooden box is sufficient to assure their preservation during the voyage.

It is desirable, I believe, that the last method of exporting seeds—that is to say, that of the dried fruit—be given the preference. There are, in fact, even in the berry, distinctive characteristics very valuable in determining species. Moreover, it must not be forgotten that the seeds thus preserved in their natural state, in a more or less aqueous pulp, never run the risk of such long drying as the seeds that are deprived of the protective envelopes which the fruit constitutes for them.

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[1] Foëx, *Rapport sur les Expériences de Viticulture*, etc., Montpellier, 1879.

As I have already done, in the preceding chapters, I shall insist more particularly, in this rapid review, on the wild vines of Missouri. Then there will be given the means of recognizing the most important cultivated varieties, hybrids, or otherwise. And, since some of these bear traces of a more or less close relationship to the European vine (*V. Vinifera*), or to the *V. Labrusca*, it will also be necessary to take these last two species into consideration. Finally, there will be found a necessary complement to this chapter in the study of seeds of *V. Rotundifolia* and *Candicans*, wild types almost as interesting as the species precedingly named.

Before entering upon the subject, it may not be useless to define certain botanical terms not in common use.

The fruit, in the genus vine, constitutes what is commonly called the grape; for botanists it is a *berry*. It contains at the most, and that quite rarely, four seeds or stones; sometimes three; generally two or only one; seldom none.

The seeds, elongated, taper down, at one extremity, to a sort of beak of greater or less length, and are rounded on the opposite extremity. They are inserted by the beak in a vascular tissue, slender and short, which comes from the stem of the fruit, so that their length corresponds to a prolongation of this stem; they are therefore erect with respect to it. Consequently the beak constitutes their lower extremity; the opposite rounded end is their upper extremity. When there are several seeds in a berry, we designate by the name of ventral or internal face of the seed, that side which is turned towards the center of the fruit, or if we wish, that on which the seeds face each other. When there is but one seed, we give this name to the corresponding face. The dorsal face, opposite the preceding, is that facing the exterior, the skin of the berry.

The ventral face presents two depressions symmetrically disposed on each side of the middle line of the seed. The shape, depth, and disposition of these depressions vary greatly in the same species, according to the number of seeds, and generally are not characteristic.

The dorsal face presents, near the middle, a sort of elevation, designated in botany by the name of *chalaze*, situated in a depression more or less broad and deep, is prominent or scarcely marked, round, etc. From the chalaze comes a cord more or less prominent, extended upwards, which passes over the upper extremity of the seed, and then is lost in the median line of the latter, about the middle of the ventral face, or a little above it; this is the rhaphe.

Vitis Æstivalis (Michaux).—Berry of a violet black color, with a prune-colored bloom, on an average about one fourth of an inch in diameter, of good taste and sweet flavor; usually containing two or three seeds—seldom four—say twenty or twenty-five seeds for ten grapes. In one gramme there are forty seeds. About three thousand eight hundred berries are reckoned upon in one pound of fruit.

Seeds, general color that of a dead leaf, tinted orange yellow by the color of the beak and ventral depressions—small (average length two tenths of an inch, average breadth sixteen hundredths of an inch), beak short, obtuse, often presenting at the extremity, on the ventral face, two small lateral veins or wrinkles. Upper extremity rounded, not bilobate, or only slightly so. Chalaze situated in the center of the seed (considering it lengthwise), rounded, very prominent, surrounded by a very marked depression, excepting at the point where it is joined to the rhaphe. The latter, rounded, passes over the upper extremity of the seed and terminates insensibly in the center of the ventral face. (See plate, Fig. 1).

To the type *Æstivalis* belong naturally the seeds of the *Jacquez* (Fig. 17), *Cunningham*, *Long* (Laliman), *Herbemont* (Fig. 18), and *Rulander* (Fig. 19). It is generally easy to distinguish the seeds of these varieties from those of the wild type; on the one hand, by their dimensions, and especially their somewhat greater length; on the other hand, by the lack of the orange yellow coloration of the beak and ventral depressions, or at least by its not being so intense. As for distinguishing the seed of one variety from that of another, that appears to me almost impossible in the majority of cases. However, it may be observed, that in the *Jacquez* (Fig. 17.) the beak is elongated, and the chalaze situated a little above the center of the seed, characteristics that may be indicative of a distant relationship with the *V. Vinifera.* In the *Rulander* (Fig. 19) are found analogous characteristics, but less marked. The seeds of the latter are distinguished, moreover, by a general light color, tinted a lemon yellow on the beak and the ventral face. The seeds of the *Cynthiana* and *Norton's Virginia* seem to have a more globular shape than most of the other varieties. The *Cunningham,* on the contrary, is more elongated in shape. The latter might probably be recognized also by the peculiar red color of the seeds, and by the absence of all yellow coloration of the beak and ventral depressions. In the *Herbemont* (and *Hermann?*), the seeds generally show great resemblance to those of the type, and can be distinguished from them only by a diminution in intensity of the yellow coloration of the beak and ventral depressions. Finally, the seeds of the *Eumelan* (Fig. 20) show, as do all other parts of the plant, certain traces of hybridization by *V. Labrusca.*

Vitis Cinerea (Engelmann).—Berries, without any prune colored bloom, of a glossy black color, on an average one fifth of an inch in diameter, of good taste, of sweet but acid flavor, containing generally a single seed, very rarely or hardly ever four seeds (say twelve or thirteen seeds for ten grapes), forty-seven seeds are reckoned to the gramme, that is about twenty-one thousand three hundred and sixty to a pound. This same weight of fruit contains about five thousand nine hundred and ten berries. Seeds, general color that of a dead leaf (ventral depressions of a lighter color), a little smaller or almost the same size as those of *V. Æstivalis* (average length eighteen hundredths of an inch, breadth sixteen hundredths of an inch). Beak of the general color of the seed or of a little deeper shade, very seldom showing the two lateral veins observed in the *V. Æstivalis.* Chalaze sensibly the same as in the latter species. Rhaphe a little narrower than in the *V. Æstivalis,* ending in the upper part of the ventral face of the seed (Fig. 4).

The fruit of *V. Cinerea* is easily distinguished from that of *V. Æstivalis* by its small size and acidity, by its color being blacker and glossy, and the absence of prune-colored bloom, and by the smaller number of seeds to a given number of berries.

As for the seeds, they may be distinguished from those of *V. Æsti-*

valis, first by a lack of the orange yellow coloration of the beak and ventral depressions, then by their average length being less and their form generally more globular, and finally by the very great narrowness and shortness of the rhaphe on the ventral face.

Vitis Cordifolia (Michaux).—Berries of a dull violet black, without any prune-colored bloom; on an average twenty-eight hundredths of an inch in diameter; of an acidulous, disagreeable, and more or less nauseous flavor; containing generally one, sometimes two seeds; rarely three, say eleven or twelve seeds to ten grapes. One gramme contains thirty seeds. In one pound of fruit there are about four thousand five hundred and forty-five berries. Seeds of a general olive-brown color, or of a wineish-brown, with beak tinted a dark red, and ventral depressions, colored a greenish yellow; of average size, (average length, from two tenths to twenty-four hundredths of an inch, by eighteen hundredths of an inch in breadth); somewhat irregular in shape; beak of average length, slightly bilobate on top; upper extremity of the seed slightly bilobate; chalaze and rhaphe like those of *V. Æstivalis*, but thicker and more marked, and lodged in a deeper depression; the rhaphe, as in the *V. Æstivalis*, terminates in the center of the ventral face (Fig. 2).

It is easy to distinguish the fruit of *V. Cordifolia* from that of the *V. Æstivalis*, which are of the same size, by the lack of all prune-colored bloom, and by its peculiar, disagreeable flavor.

As for the seeds, they are distinguished from those of *V. Æstivalis* and *Cinerea*, which in their general appearance they greatly resemble, by their more considerable size, their much stronger beak, bilobate, and colored a dark red, and by their general olive tint.

Vitis Riparia (Michaux).—Berries of a violet black, with a prune colored bloom of average diameter of from twenty-four to twenty-eight one hundredths of an inch, surpassing all the species precedingly named by the richness of the violet coloring matter contained in them; of acidulous flavor, and rather disagreeable after-taste; usually containing one or two, seldom three, seeds, that is, fifteen or sixteen to ten grapes; sixty-five seeds weigh one gramme, that is reckoning about twenty-nine thousand five hundred and forty-five to one pound of seeds; the same weight of fruit contains about seven thousand two hundred and seventy berries; seeds of a chocolate color in general, with ventral depressions of a brighter red tint, and beak of a deep shade on top, small (average length sixteen one hundredths of an inch by twelve one hundredths of an inch in breadth); beak very short and slender, upper extremity bilobate; chalaze not prominent; oval, broader on the lower side than on the upper, where it terminates imperceptibly in a linear rhaphe scarcely marked, hidden at the bottom of a depression of average depth (Figs. 5. and 6).[1] The fruit of this species, scarcely larger than that of *V. Cinerea*, is easily distinguished from it by its prune colored bloom. As for the seeds, they are recognized at first sight by their elongated chalaze, terminated imperceptibly in an extremely slender rhaphe. They can be confounded only with those of *V. Rupestris*, from which, it seems to me, they can be distinguished by their general shape being narrower, and their beak longer.

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[1] (Note added during printing.) I received, at the last moment, from Mr. Englemann, several samples of seeds and fruit of a wild variety of *Riparia*, a native of Iowa, called *V. Riparia Baccis Majoribus*. As far as I can judge from the dried fruit, the berries are, in fact, a little larger than in the *V. Riparia* of Missouri; their flavor is the same. They contain, also, for the most part, a single seed. The seeds are somewhat globular, short and thick, and larger than in the Missouri type (length two tenths of an inch, breadth sixteen one hundredths of an inch), very nearly the size of those of the *Solonis*; they are also heavier, for we may reckon twenty-three to the gramme, that is about ten thousand four hundred and fifty-five to the pound. The beak is short, very thick, and the upper extremity bilobate. As we see, these hardly differ from those of the type from Missouri, excepting in their size.

Of all the seeds furnished by American varieties, which ampelographists group around *V. Riparia*, those that approach nearest to the wild type under consideration, are from the *Solonis*; nevertheless, they may be easily distinguished at first sight simply by the difference in size, those of the *Solonis* being three or four times as large (average length twenty-four one hundredths of an inch by two tenths of an inch in breadth); the latter are distinguished, moreover, by a general shape more irregular, and shorter and thicker, a lighter color, and a rhaphe and chalaze still less prominent than in the type, characteristics that seem to indicate some affinity with *V. Rupestris* (Fig. 23).

As for the *Clinton* (Fig. 12), *Taylor* (Fig. 11), and *La Touratte*, their seeds betray in their size and most of their characteristics evident affinity with *V. Labrusca*. It is the same for those of the *Marion*, *Elvira*, and *Franklin*, if the seeds I have before me, and which come from Mr. Champin, really belong to these varieties. All these seeds present in a more or less apparent degree the elongated chalaze of *V. Riparia*, as well as the following characteristics which we shall soon find in the *V. Labrusca:* Considerable size of the seed; bilobate form of the upper extremity; depth and width of the depression containing the chalaze; more or less complete obliteration of the latter; linear rhaphe situated in a deep, wide groove; and the yellow coloration of the lower part of the seed.

Vitis Rupestris (Scheele).—The fruit of this plant is unknown to me. Mr. Engelmann informs us[1] that it is of medium size, and generally contains three or four seeds, and that its flavor is sweetish (luscious; sugar grape). In Missouri, it ripens during the month of August. I have had at my disposal several seeds of this species gathered near Toulon, at Mr. Canzin's. They are small, almost as broad as long (length, eighteen one hundredths of an inch; breadth, from fourteen one hundredths to two tenths of an inch), somewhat globular, irregular, and not symmetrical. The beak is very short, slightly pointed, inflected on the inside—that is to say, somewhat hooked, and presenting two punctuations on the top. The upper extremity rounded; not bilobate. Chalaze elongated, its lower extremity reaching, as in the species precedingly spoken of, the center of the seed, situated in a very slight depression, and ending, as in the *V. Riparia*, on the upper side, terminating in a scarcely apparent rhaphe represented by a very fine line (Fig. 8).

Vitis Labrusca (Linné).—The berries of this species are very large, oblong; average length about three fourths of an inch; of a glaucous black. Their flavor is so foxy that it is hardly tolerable.

The seeds (Fig. 9) are very large—average length twenty-eight hundredths of an inch, breadth two tenths of an inch; their beak is long and colored yellow, as are also the ventral depressions; the upper extremity is more or less deeply bilobate; a little below the middle of the dorsal face is found a deep, wide depression, in the center of which is a somewhat irregular and not prominent chalaze; the rhaphe is reduced to a mere line, situated at the bottom of a groove.[1]

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[1] Bush's Catalogue, and others.

The seeds of the *Diana*, and those of the *Isabella* (Fig. 10) and *York-Madeira* (Fig. 21), present about the same characteristics as those of the type, although it is certain that the *York*, and only possible that the *Isabella*, are not pure *Labrusca*. It has been seen previously that it is easy to recognize, in the seed only, crossing with *V. Labrusca* in the case of the *Taylor*, *Clinton*, *Eumelan*, *Elvira*, *Marion*, etc.

Vitis Candicans (Engelmann).—The berries of the *Mustang* are similar in size to those of *V. Labrusca* and *Rotundifolia*.

The seeds are found in commerce. The following description has been given from samples gathered in Texas, by Mr. Onderdonk:

They are very large (average length twenty-six hundredths of an inch, and breadth eighteen hundredths of an inch); of a cinnamon or chocolate color, usually not symmetrical (Fig. 3); upper extremity slightly bilobate; lower extremity terminated in a somewhat prismatic beak, of a brown color; chalaze broad, of medium prominence, slightly rounded on the lower side, tapering imperceptibly on the upper side, descending a little below the center of the seed; rhaphe almost indistinct, in a rather deep groove; ventral depressions converging below, of a reddish color, lighter than that of the rest of the seed.

The *V. Candicans* is common in the lower part of the Mississippi valley and in Texas. According to some accounts it is used there as grafting stock for the European vine, which could not thrive there without this precaution. I do not know that any attempt has been made to graft our varieties on it in France. If this operation would be successful, it would still be indispensable, before cultivating this plant, to make sure first that it is adaptable to the climate of our regions, which is much colder than that of its native places.

Vitis Rotundifolia (Michaux).—Berries, very large.

In the *Scuppernong*, the cultivated form of this species, there are usually two or three seeds. They are (Fig. 22) of great size (average length three tenths of an inch, breadth two tenths of an inch); shining; of tobacco color, tinted yellow on the beak and in all the depressions; general shape, oblong; beak, very short, slightly pointed, upper extremity not bilobate, somewhat rounded; dorsal face, divided throughout its length by a longitudinal depression, whence issue oblique grooves, more numerous about the center of the seed, the depression widens very much at this point where is found the oval chalaze, which is not prominent, and is of a yellowish color; rhaphe apparent only on the ventral face; linear, narrow; ventral depressions parallel, having several irregular channels branching off from their outer edge. This species inhabits that part of the North American continent situated south of latitude thirty-six degrees, where its varieties are frequently cultivated. In our climate, its vegetation is poor. We have already seen that it is refractory to the grafting of our European vine.

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[1] The seed illustrated by Mr. Foëx (Rapp., etc., pl. 1, fig. 6), under the name of *V. Monticola*, must be ascribed to *V. Labrusca*.

Vitis Vinifera (Linné).—The description that will follow has been given from seeds gathered in 1874, between Luz and Pierrefitte (Hautes-Pyrénées), at an altitude of about one thousand nine hundred and seventy feet. The ruggedness of the site, the presence of a great many males in the midst of the fertile plants, finally, the considerable number of vines spread over a surface of nearly an acre in extent, attest that if the plant which I have had some experience with has not been a native of this gorge from the remotest time, it has at least fallen into a wild state there for centuries past. Besides this, we find the characteristics which I am going to point out, with the exception of the dimensions, in the cultivated species *Chasselas* (Fig. 15), *Cabernet* (Fig. 16), *Aramon*, etc., and nothing would be easier than to recognize the corruption of American seeds through contamination of those of any European variety.

Seeds (Fig. 14) of average dimensions (length, twenty-four one hundredths of an inch; breadth, from fourteen to sixteen one hundredths of an inch), of a general elongated shape, somewhat irregular; more or less deeply bilobated on the upper extremity; tapering at the opposite extremity down to a long beak, which is slender, obtuse, and more or less broadened at its extremity; chalaze not prominent, rounded, somewhat larger in proportion than the other species, always situated above the center of the seed, often almost reaching the upper third part of the latter; rhaphe not prominent, linear situated at the bottom of the groove.

The illustrations which I give of the seeds of the *Delaware* (Fig. 13) denote great affinity of this plant with the *V. Vinifera.* It is on this characteristic, and on still others which I cannot dwell upon here, that I based my opinion that this variety, although of American origin, is a hybrid of *V. Labrusca* and *Vinifera.*

RÉSUMÉ.

Here are the most important facts given in the course of this study:

First—The following species of vines: *V. Riparia, Cordifolia, Æstivalis, Cinerea*, and probably the *V. Rupestris*, are infinitely more resistant to phylloxera than the most resistant cultivated varieties. Their resistance must be regarded as absolute.

Second—These species may be utilized as grafting stocks for our European varieties.[1]

Third—We know how important it is to use as grafting stocks only plants free from all crossing with non-resistant species, the *V. Labrusca*,[2] for example. As this last species is absolutely foreign to the basin of the Mississippi, it will suffice, in order to satisfy the above condition, to procure the wild grafting stocks from this very region.

Fourth—The seeds of these species germinate with facility in the open ground, and furnish grafting stocks excellent in all respects, after the second or third year, according to the climate. I suggest using them.

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[1] To keep within the limits of authenticated facts, I must say that while the grafting of *V. Rupestris* on our European varieties meets with good success, I do not yet know of an example of the inverse operation.

[2] This is not to say that there are not hybrids of *Labrusca* resistant in the highest degree. I admit, in fact, that the *York-Madeira* and *Pedroni* are somewhat related to *V. Labrusca* (in the *Question des Vignes Américaines*), a fact that does not prevent my putting them, with respect to resistance, by the side of the *V. Solonis*, only a little below the wild species under consideration in this study. What I wish to say is that, à priori, when dealing with a form whose resistance is completely unknown, if that form presents characteristics of *Labrusca*, it should be regarded as suspicious with respect to resistance.

Fifth—The use of seeds presents many considerable advantages over that of cuttings, which has alone been in vogue up to the present time. One advantage is the easy multiplication of the grafting stocks most refractory to propagation by cuttings; another, the lowering to the most moderate price that could be desired, of the cost of these same grafting stocks; finally, by this means, there will no longer be the least danger of introducing phylloxera in a non-infested country.

Sixth—The seeds of wild vines, as well as those of cultivated varieties, present such distinct characteristics that it would be possible to recognize with perfect certainty, corruption by seeds of non-resistant vines.

NOTE.

ON THE RELATIONSHIP SHOWN BETWEEN PHYLLOXERA AND V. LABRUSCA, IN THEIR GEOGRAPHICAL DISTRIBUTION.

[Extract from *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux, t. III*, (2d *Série*), 2d *cahier*.

I have shown, for more than two years past, by conclusive facts, that the type *V. Labrusca* succumbs to phylloxera.[1]

This fact seems hard to reconcile with the simultaneous presence of the insect and the species of vine in question in certain regions of the United States. It seems, in fact, that wherever the phylloxera is found, the existence of *V. Labrusca*, both in the wild state and in the cultivated, must be impossible. An intelligent person, familiar with the facts of natural history, certainly could not refuse to admit that, if this conclusion is not altogether exact, it is, however, sufficient approximation to the truth.

True, it might be asked if, when asserting the existence of *V. Labrusca* east of the Alleghanies, Mr. Engelmann might not have erred, and have sometimes confounded the *V. Labrusca* type, non-resistant to phylloxera, with certain forms of *Labrusca* hybridized by *Æstivalis* or *Riparia*, and, consequently, capable of resistance. This hypothesis seems improbable; besides, it entails a host of difficulties.

It appears much more natural to admit that if, as Engelmann asserts, the *V. Labrusca* is widely spread in a spontaneous state east of the Alleghanies; its presence in that region coincides with the primitive absence of phylloxera. According to this hypothesis the introduction of the insect east of the Alleghanies would be of relatively recent date, and due, probably, to man. The phylloxera, in the first place, would have been transported from the basin of the Mississippi to the vineyards of the eastern region, whence it would already have been able to spread to divers parts of the forests, and infect the wild vines. This explanation seems to me for the time the most natural, and without doubt, deserves to be taken into consideration by American naturalists.

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[1] *La Question des Vignes Américaines*, pp. 35 and 36.

True, it is contrary to the assertions of Mr. Planchon, who says he has found phylloxera from Canada to Florida.

But already, in 1874, struck by certain evidences which Mr. Laliman had put before me, I was brought to greatly limit the bearing of the affirmations of my learned colleague of the *Facultê des Sciences de Montpellier.* "It is not more difficult," said I, "to find vineyards exempt from phylloxera in America than it would be in France."[1] Here is one proof.

The following facts are highly instructive, and require some details: Some time after the publication (*Revue des Deux Mondes,* 1874) of the article in which Mr. Planchon asserted the presence of phylloxera throughout the whole of the United States, Mr. Laliman asserted, on his side, according to the testimony of many reliable American viticulturists or naturalists, that phylloxera does not exist in Georgia, at P. J. Berckmans' place, whence he had received most of his vines. He even produced a letter, written by his opponent, Mr. Planchon, himself, in which the eminent Professor, acknowledging the reception of a lot of American vines from the latter, declared he had "found them perfectly healthy and bearing not races of phylloxera."[2]

The argument was unanswered, and Mr. Laliman triumphed; but that did not last long. Four months after having planted Mr. Berckmans' vines, that is to say, in July, Mr. Planchon had them dug up, and declared "that on the roots of three of them (Taylor) he found not only living phylloxeras, but old nodosities attesting the presence of the insect the preceding year."[3]

It was easy to account for the living phylloxeras, since they were not rare in Mr. Planchon's estate, but the old nodosities constituted a more serious argument, and Mr. Laliman was obliged to come to the conclusion that he was wrong.

But, oh, turn of fortune! as I was about to present the advantage to be derived from this pamphlet, this twelfth of June, 1879, behold Mr. Laliman puts before my eyes a copy of the New York *Sun,* for May twenty-first, of the current year, in which is an article entitled: *The Phylloxera and American Grapes.* In the first lines I read the following: Professor Riley, in an address before the Missouri Horticultural Society, referred to the phylloxera and said:

> I am glad to be able to confirm, in this connection, the truth of the statement of Mr. P. J. Berckmans, of Augusta, Georgia, namely, that the insect does not occur in that locality. While spending a few days with him last September, I was able to verify its non-occurrence there.

Then, how about these old nodosities, discovered so laboriously by Mr. Planchon, in July, 1874, and which enabled him to put Mr. Laliman to silence. Instead of coming from Georgia, might they not have been produced simply by the phylloxera of Herault? It is allowable to suppose so, for Mr. Planchon has not stated by what characteristics he was able to distinguish, with such certainity, nodosities about one year old and coming from America, from those that might have been able to form in his own vineyard, and mature completely in the space of only four months.

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[1] *Etudes sur les Vignes d'Origne Americaine qui Resistent au Phylloxera,* p. 45—Paris, Gauthier, Villars.

[2] See *Bulletin de la Société d'Agriculture de l'Hérault, 62d année,* p. 271.

[3] Planchon, *Les Vignes Américaines, leur culture,* etc., Montpellier, 1875, p. 48.

While waiting for this difficulty to be explained, it seems to me to be sufficiently established that phylloxera does not exist in Augusta, Georgia. If it is not in Mr. Berckmans' vineyards, which are at least fifteen or twenty years old, it cannot exist in the surrounding forests; therefore, it is not astonishing that *V. Labrusca* can grow in that region.

Would this statement be a more general one? It is the part of American naturalists to set forth what relationship is shown between *V. Labrusca* and the phylloxera, in their geographical distribution; I simply wished to give one solution of this problem[1].

EXPLANATION OF THE ILLUSTRATIONS.

Most of the illustrations are in pairs. One represents the dorsal face of the seed; the other its ventral face. They represent average specimens. All have been drawn very exactly, on a scale of twice the real size, in such a way that the proportions in size are kept perfectly. By measuring them with the aid of a graduated ruler, and diminishing the number of millimetres thus found, one half the real dimensions of the seeds may be obtained, at least within one fiftieth of an inch. I endeavor to give, not rough outlines, but, together with the important characteristics, the general appearance of the seed.[2]

Fig. 1—*V. Æstivalis,* from Missouri.

Fig. 2—*V. Cordifolia,* from Missouri.

Fig. 3—*V. Candicans,* (Mustang) from Texas.

Fig. 4—*V. Cinerea,* from Missouri.

Fig. 5—*V. Riparia,* from Missouri.

Fig. 6—*V. Riparia,* from Missouri, *Soyer-Villemet* herbarium.

Fig. 7—Two seeds taken from the same bunch of grapes. The leaves annexed to the latter present evident analogies with the leaves of *Æstivalis.* I regard these two seeds as coming from a hybrid plant formed by the crossing of *V. Riparia* and *Æstivalis—Soyer-Villemet* herbarium. Specimens gathered in St. Louis (Missouri), by Riehl.

Fig. 8—*V. Rupestris;* seeds sent by Mr. V. Ganzin, gathered in Toulon.

Fig. 9—*V. Labrusca;* seeds from a typical vine belonging to Mr. Laliman.

Fig. 10—*Isabella;* this seed is almost exactly like the preceding.

Fig. 11—*Taylor;* by its size, the shape of the chalaze, and the indentment of its upper extremity, this seed is removed from that of *V. Riparia,* and approaches the *Labrusca* type.

Fig. 12—*Clinton;* same characteristics observed.

Fig. 13—*Delaware;* by the position of the chalaze, very much above the center of the seed, this variety evidently approaches the *V. Vinifera.* The other characteristics are common to this last species and to *V. Labrusca.*

Fig. 14—*V. Vinifera;* from the Hautes-Pyrénées.

Fig. 15—*Chasselas.*

Fig. 16—*Cabernet.*

Fig. 17—*Jacquez;* affinity with types other than the *V. Æstivalis* is most obscure.

Fig. 18—*Herbemont;* same remarks.

Fig. 19—*Rulander;* same remarks.

Fig. 20—*Eumelan;* aside from the rounded form and the prominence of the chalaze, this seed does not possess any characteristic of *Æstivalis.* No doubt the *Eumelan* is a hybrid of *Æstivalis* and *Labrusca.* Moreover, all the other organs of the plant prove this at first sight.

Fig. 21—*York-Madeira;* has the general characteristics of *Labrusca,* but is shorter and thicker.

Fig. 22—*V. Rotundifolia;* (*Scuppernong*); seeds sent by Mr. Foëx.

Fig. 23—*Solonis;* general characteristics of *V. Riparia,* but of a more rounded shape and of larger size. The general shape of this seed seems to indicate some affinity with *V. Rupestris.*

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[1] According to report from the French Consul at Charleston (*Le phylloxera, Comites d'etudes et de vigilance, 9th fascicule,* p. 204), it seems probable that phylloxera, is in fact, much rarer east of the Alleghanies than is usually admitted.

[2] The reader may compare with these illustrations the sketches of seeds of the principal species of American vines, given by Mr. Englemann, in Bush's illustrated catalogue.

APPENDIX C.

CARBON BISULPHIDE

AND

SULPHO-CARBONATES.

BY

JOHN H. WHEELER,

Secretary of the Board of State Viticultural Commissioners of California.

CARBON BISULPHIDE AND SULPHO-CARBONATES,

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To operate intelligently with carbon bisulphide one must first possess a comprehensive knowledge of its nature, qualities, and its peculiar action under varying circumstances. It is so different from any ordinary material used in everyday life, that the vineyardist must be specially instructed in its use. First, what is it? second, how does it act; if by vapor, then how far from the point of injection does the vapor act with sufficient toxical strength to destroy the phylloxera and its eggs? Again, what strength of the vapor will the vine endure without injury?

As an insecticide the bisulphide of carbon was completely tested in 1877–78 by the *Comité Reginale*, instituted at Marseilles under the patronage of the *Compagnie des Chemins-de-Fer de Paris à Lyon et à la Méditerranée.* Their experiments, I propose here to give briefly, knowing their results to be those of accurate determination, by authority rendered reliable by the high standing of all engaged in the prosecution of the work.

I refer more especially to Professor A. E. Marion, Professor of the Faculty of Science at Marseilles, who was assisted by M. Talabot and others.

NOTE.—Before proceeding with the study of insecticides the reader will find it to his advantage to read the biology of the phylloxera, as given by Prof. Foëx, in the translated work on American vines accompanying this report.

Before commencing, however, a few remarks on the chemical and physical properties may not come amiss. The bisulphide of carbon is a heavy, oily, transparent liquid, consisting in 100 parts, of 15.8 parts of carbon, and 84.2 parts of sulphur. The liquid is very volatile at ordinary temperatures, boiling at 111° Fahr., and possesses a very disagreeable odor. It does not combine with water or spirits of wine, but in ether, chloroform, and alcohol is freely soluble; it is an excellent solvent for resins, essential and fixed oils, caoutchouc, gutta percha, camphor, sulphur, phosphorus, and iodine. It is highly inflammable, burning with a red-blue flame; the products of complete combustion, being sulphurous anhydride, and carbonic acid. The vapor of bisulphide of carbon with oxygen or air, constitutes an explosive mixture. Observing the above, we may keep the bisulphide under a layer of water, and thus prevent its evaporation; glue should be used for sealing the vessel containing bisulphide, and not rubber or oily material of any kind. It must be kept away from fire, although it is not more dangerous than alcohol. If placed in an open vessel in the sun it would soon disappear by evaporation.

DIFFUSION OF CARBON BISULPHIDE VAPOR IN THE SOIL, AS DETERMINED BY PROFESSOR MARION AND OTHERS.

The method adopted for determining the diffusion of carbon bisulphide vapor in the soil, consists in passing through a solution of caustic

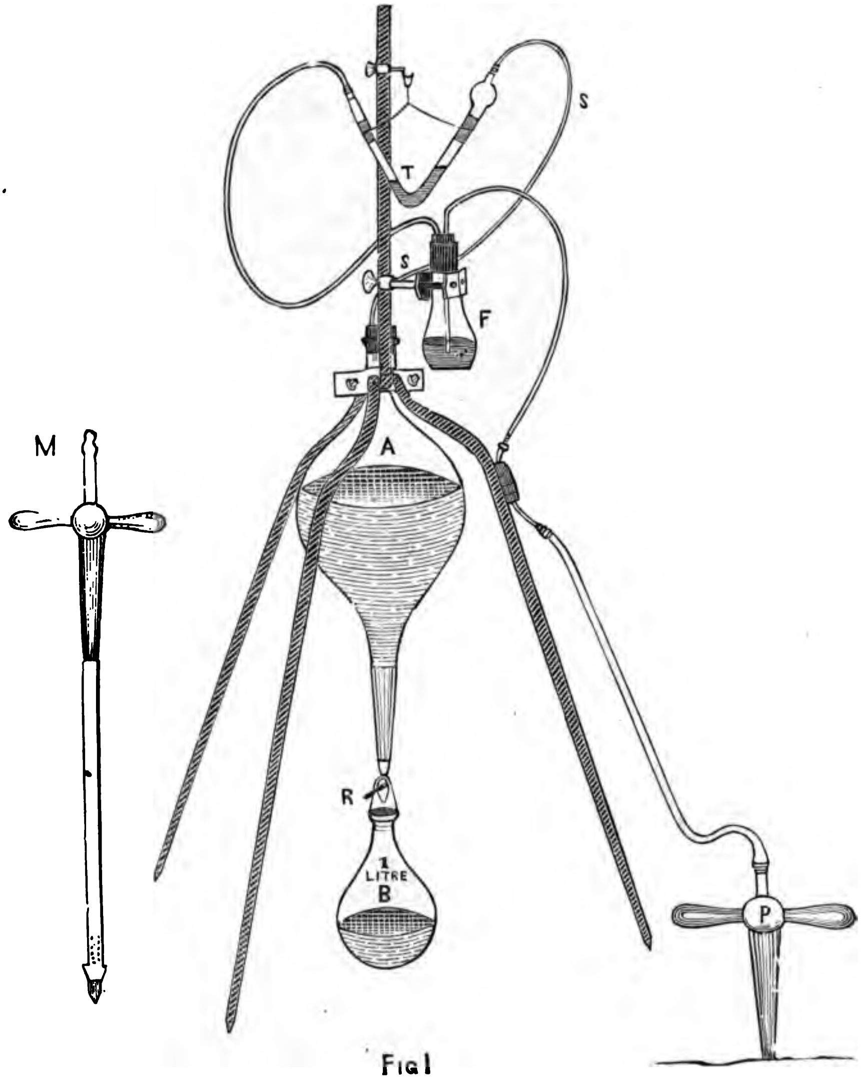


FIG 1

APPARATUS FOR DETERMINING THE DIFFUSION OF SULPHIDE OF CARBON IN THE SOIL.

Explanation.—A, Aspirator balloon; B, Litre gauge flask; R, Faucet; P, Aspirator; F, Flask of concentrated sulphuric acid; T, V-tube containing reagent; S, Tube communicating with the balloon A; M, Aspirator at the bottom of which may be seen the opening into which the vapors pass to ascend the tube of the aspirator. Beneath the handle of the aspirator is a conical arrangement to close the hole completely while the vapor is being drawn in.

potash in alcohol, two litres of air drawn from beneath the surface of the soil, at different distances from the point at which the bisulphide has been injected. The vapor of bisulphide, which is here mixed with the atmosphere contained in the soil, in being caused to pass through the above solution, forms with it the xanthate of potassium as follows:

$$CS_2+(C_2H_5)\ KO=C_2H_5KCO,\ S_2.$$

The xanthate may be easily tested by the addition of a few drops of copper sulphate solution, after having neutralized the former with dilute acetic acid. This gives a beautiful yellow precipitate of xanthate of copper. The apparatus used in this experiment is represented in Fig. 1, and consists of a tubulated balloon aspirator, with a faucet at the bottom for drawing off the liquid into a litre flask suspended beneath.

By its opening on top, the balloon communicates with one of the branches of a V-shaped tube containing the alcoholic solution of potash, destined to retain the bisulphide vapors. The other branch of the V-tube is connected with a flask of concentrated sulphuric acid. This last flask is connected by rubber tubing with the aspirator, which draws the vapors from the soil. The aspirator tube is metallic, and perforated at its point. Handles at its upper end permit of its being forced into the ground to the desired depth.

The balloon being filled with water, connections made, and the tube inserted into the soil, it is only necessary to open the faucet to allow the water to flow out of the balloon, and thereby draw from the soil a determined volume of subterranean atmosphere. This air passes successively through the sulphuric acid, where it is deprived of whatever moisture it may possess, and also any particles carried in mechanically; then into the tube where the bisulphide vapor is retained, forming xanthate of potassium.

In the experiments made by Professor Marion and others, three of these aspirators were employed. When the earth was dry at the point where the tube was inserted, to prevent the air from above ground being drawn in, the surface was moistened and packed. After drawing in one litre, the instrument would be removed, and then free air passed through to empty the apparatus of any trace of the bisulphide, preparatory to the next experiment, and also to get in the xanthate all of the bisulphide vapor inhaled.

In order to determine what expansion the vapors have reached in a certain length of time the three aspirators are placed, preparatory to operating, at different distances from the point of injection of the bisulphide, and set to operating simultaneously. One or two experiments suffice to fix the distance to which the bisulphide vapor has diffused; and by repeating the operation from hour to hour, one may follow exactly the variations in the circle of diffusion. Suppose, for example, that the three aspirators were placed, the first at sixteen inches, the second at twenty-four inches, and the third at thirty-two inches from holes into which the sulphide has been injected. We then know approximately the diffusion if the first aspirator gives a marked reaction, the second a feeble one, and the third none. It may be then said that the vapor has already included a circle whose diameter is forty-eight inches, and that it has not yet attained thirty-two inches from the point of injection. Another similar experiment made between those two limits determines precisely the limit of diffusion. When the vapors, continuing to expand, are recognized at thirty-two inches, the new limit may be determined by placing one of the instruments still further from the point of injection.

These experiments continued successively for days and nights until all signs of the vapor have disappeared, enable one to state accurately the limit of its toxical action in the various kinds of soil, and also to determine the most effective quantity to be applied in a single dose, as regards economy of material. The results of two experiments are expressed in the following tables:

TABLE *showing the Diffusion from the Point of Injection, of Five Grams of Carbon Bisulphide, obtained in November and December,* 1877.

	Hours of the Day.	Number of Hours from the time of Injection.	Distances (inches from the point of Injection) reached by the Vapor.	Temperature, Fahrenheit.
November 28th	6	0	0	47°
	10	4	18	44
	6	12	32	42
	10	16	20	42
November 29th	2	20	34	40
	7	25	23	40
	1	31	36	50
	8	38	20	45
November 30th	1	43	24	42
	8	50	32	42
	2	56	20	43
	12	66	34	41
December 8th	8	74	20	37
	3	81	16	48
	8	86	20	40
	12	90	21	40
December 2d	4	94	20	41
	10	100	28	48
	2	104	17	50
	5	107	24	43
December 3d	1	115	3	37
	12	126	13	43
	8	134	8	42
	10	136	6	41
December 4th	1	139	3	40
	10	148	9	44
	2	152	4	48
	8	158	8	42
December 5th	1	163	9	41
	7	167	4	42
	10	172	7	45
	2	176	3	50
December 6th	1	187	8	37
	8	194	2	35
	12	198	4	42

TABLE *showing the Diffusion from the Point of Injection, of Twenty Grams of Carbon Bisulphide, obtained in November,* 1877.

	Hours of the Day.	Number of Hours from the time of Injection.	Distances (inches from the point of Injection) reached by the Vapor.	Temperature, Fahrenheit.
November 12th	12	0	0	53°
	4.	4	16	53
	8	8	16	48
	12	12	16	44
November 13th	6	18	20	40
	9	21	48	44
	7	31	23	44
	12	36	22	41
November 14th	5	41	18	36
	10	46	68	54
	7	55	20	43
	12	60	30	42
November 15th	2	62	24	45
	10	70	50	52
	2	74	32	64
	8	80	32	44
November 16th	1	85	20	42
	10	94	60	50
	6	102	32	45
	9	105	48	48
November 17th	2	110	28	43
	10	118	48	50
	7	127	20	45
	12	132	36	44
November 18th	4	136	22	42
	10	142	50	48
	4	158	28	50
	6	150	32	44
November 19th	4	160	18	42
	9	165	36	44
	2	170	30	50
	6	174	40	42
November 20th	2	182	22	38
	12	192	28	48
	4	196	40	44
	10	202	16	42
November 21st	4	208	30	39
	10	214	22	42
	2	218	14	45
	8	224	18	42
November 22d	2	230	34	40
	8	236	24	42
	3	243	27	53
	10	250	14	45
November 23d	4	256	14	48
	8	260	18	45
	2	266	14	53
	11	275	28	48

TABLE—Continued.

	Hours of the Day.	Number of Hours from the time of Injection.	Distances (inches from the point of Injection) reached by the Vapor.	Temperature, Fahrenheit.
November 24th	8	284	10	48°
	4	292	14	50
	6	294	12	45
	10	298	14	44
November 25th	6	306	6	42
	10	310	14	48
	6	318	6	42
	12	324	10	36
November 26th	6	330	5	36
	1	337	6	48
	8	344	6	33
	12	348	8	30
November 27th	1	349	6	28
	6	354	9	35
	10	358	8	42
	12	360	4	48

To ascertain, by means of the preceding tables, the distance from the point of injection to which the vapor of twenty grams has extended in twenty-one hours, pass down the column headed "Number of hours from the time of injection," in the second table, until arriving at the number "21." The figure "48," in the column headed "Distances," etc., corresponding, it represents the number of inches from the point of injection to which the vapor has passed at nine o'clock A. M., the thermometer standing at forty-four degrees Fahrenheit.

It is interesting to note that the curve of diffusion precedes in its variations the curve of temperature; that is, the maximum expansion precedes slightly the maximum temperatures of the day, the minimum for the night corresponding. Concerning the barometric pressure, which was observed carefully, there seems to be no apparent influence on the diffusion.

As to the duration of the vapor in the soil at different seasons of the year, it was found that in Spring the continuance of the vapor in the soil is considerable; in the month of March the vapors continue recognizable for seven or eight days, if the amount be twenty grams; it is not found after six or seven days if applied in April; at this time the radius of diffusion attains forty-eight inches. But the most extended points of the curve, in the month of April, are nearer to the time of injection than they are when the injection is made in March. In Summer the vapors attain their greatest diffusion in a few hours; their persistence in the soil is reduced in direct proportion to the activity of this diffusion, in other words, the vapor is weakened toxically by expansion. In July the maximum diffusion is reached in from six to eight hours. In August the duration of the vapor is about four days, and the curve reaches its highest point in three or four hours. In October the persistence of the vapor becomes sensibly greater although the temperature of the soil is still elevated, which favors the rapid loss of the sulphide.

The maximum height of the curve constructed at this time is produced eight or nine hours after the injection. In November, operating still with twenty grams per injection, very different results are obtained; the bisulphide is found to continue in the soil fifteen days, and even with the feeble dose of five grams it continues over eight days.

The nature of the soil appears to exercise a less important influence on the condition of the diffusion than does the temperature; nevertheless, the composition of the soil is not to be neglected, as evidenced by a few experiments made in Spring; these go so far as to prove that, in certain cases, exceptional it is true, the influence of the soil can even preponderate. The last named experiments were made in March and April, when two fields essentially different were operated upon; one was of compact clay, the other one loose and gravelly. In the former the sulphide continued to act over seven and one half days. Even after this it could yet be recognized inside of six inches from the point of injection. In seeking the bisulphide vapors at the same distance in the loose soil it was found that they had disappeared at the end of six and one half days. In April these experiments were repeated in the same soils and gave analogous results, the vapor remaining observable at six inches for over six days in the compact clayey soil, and for five and one half days only in the loose soil. In similar experiments made at Roucas-Blanc, singular results were obtained, varying with the nature of the soil. The experiments were conducted in a kitchen garden, where the light soil was frequently worked or moved in garden culture. In this case the results were so irregular as to render accurate record impossible. It was noticed that the vapors passed quickly to considerable distances, and were found throughout in feeble quantities. It is readily understood, in cases of this kind, that the rapid loss from the surface of the soil, and the easy penetration to the lower depth of the soil, lessens materially the action of the vapor.

Moisture in the soil exerts, also, a decided influence in modifying the conditions of the diffusion of the vapor, and in increasing its persistence.

In a measure the longer continuance of the vapors in Autumn is attributable to the increased humidity at this season. Attention should be drawn to the important variations due to differences in the amounts injected; the results obtained at the last of November and first of December, under similar climatic conditions, furnish valuable instructions concerning this point. The results—given in the curve represented in figures two and three—demonstrate that large doses of carbon bisulphide increase the sinuosities of the curve and augment the variations in the diffusion in every sense. With twenty grams, the height which the curve attains during the first six days, represents a mean of fifty-two inches; one of these, viz: that of the second day, rises even to sixty-eight inches. The continuance of the vapor in this case reaches fifteen days; whereas, with five grams the continuance does not exceed eight days. Here, too, the curve of diffusion does not reach as high, in the second day—not exceeding thirty-six inches—and the mean hight for four days is only thirty inches.

This comparison should not, however, discourage the employment of small doses in practical work; on the contrary, it demonstrates that the continuance of the toxical effect of the vapor is by no means proportionate to the amount injected. In consulting the table for twenty grams, it is seen that the vapor continues constant for ninety-seven hours at a distance of twenty inches from the point of injection; whereas with five grams, it is shown that the diffusion to the same distance is reduced to one hundred and eighty-six hours. Thus it is seen that the diminution in time is far from being proportional to the diminution in the quantity injected. The latter is one fourth, while the diminution in time, is scarcely less than one half. This shows the economy which may be realized in practice by the repeated use of small quantities. It is only necessary to consult the curves of diffusion to explain the advantages of a treatment by repeated application over the treatment consisting of a single application, and in determining the interval of time between the operations. The vapor of the first application must not have disappeared before the second is made; or, in other words, no breathing spell must be allowed the insect.

In the foregoing we are instructed in the latteral diffusion of the vapor, and now we pass to the vertical diffusion. Injected sixteen inches below the surface, some of the vapor, after a time, begins passing off from the surface; this is shown by placing a bell on the ground into which the rising vapor passes mixed with air. The mixture, after a time, tested by the aspirator, gives a reaction with the xanthic acid and thereby proves the escape of the bisulphide. In passing downward from the surface of the soil, the intensity of the vapor increases; being much less at a depth of four, eight, and twelve inches than at sixteen inches. Passing below sixteen inches, the depth at which the liquid has been deposited, a decrease in the intensity of the vapor is observed. At a depth of four feet, the greatest depth tried with the aspirator, the toxical gas was more intense than at from four to eight inches below the surface, the horizontal distance remaining the same.

These facts are attributable to two different causes: below, an increased density exists, while above, there continues a loss from the surface, this loss diminishing as the depth increases.

Reasoning on the above, it may be stated that there arises no advantage in injecting the bisulphide deeper than sixteen inches, and it is furthermore impracticable to penetrate deeper on account of the increased labor required.

Certain invariable rules can be laid down applying to all circumstances existing in practical work. Questions of importance, to be sure, arise in each case, but with a knowledge of the preceding facts, and the exercise of ordinary discretion, these questions can be readily answered by the vinegrower as applying to the case in hand.

It is an almost invariable rule, that in March and April the carbon bisulphide continues to act for from six to seven days, if employed in doses of eight grams per hole. In this case it is not well to rely on its acting at twenty inches from the point of injection for a longer period than three and one half days. In Autumn, on the contrary, as valuable results are obtained with a quantity not exceeding five grams. At all seasons of the year injections at the rate of two holes for each one and one quarter square yards are found sufficient to completely impregnate the field. By studying the tables given, it is possible to determine accurately enough the amounts adapted to the different seasons which will produce the best results. In Autumn and Winter, a period of six days should be allowed between the two applications, if injected in doses of eight grams each, and at the rate of two holes to each one and one fourth square yards. In Spring the diffusion is more rapid, and four days only should be allowed between applications. Finally, if the application should be made in Summer, three days only should be allowed to elapse.

The vapors tend to expand more abundantly at a considerable depth than they do near the surface, and there is, therefore, no doubt that the insects on the deep roots will receive a more complete treatment than those on the surface roots; this should be borne in mind if, after any treatment, surviving insects be found at the surface on the trunk of the vine, or even on surface roots near the trunk. This part of the soil is, in fact, farthest from the point of injection, and it is, therefore, at this point that the vapors are least effectual.

DETERMINATION OF THE ENERGY OF CARBON BISULPHIDE AS AN INSECTICIDE.

To determine the insecticide properties of a chemical, the ordinary procedure is by means of a close vase. In open air it may perhaps be introduced directly into the soil of the vineyard. This last method can give only approximate results, as the accidents following this sort of work are certain to intervene to a considerable extent. For example, a certain number of vines are determined upon as infested, or at least possessing the appearance of being so; without examining each one, it is concluded that all are equally diseased, an obvious error on the start. Such methods might answer in some cases, but where fixed rules are to be determined concerning the material experimented upon, this method will not suffice. There has been selected for this work a method presenting an invariable mathematical standard of determination.

It is known by all that the root phylloxera can greatly prolong its existence on a piece of root detached from the vine and kept in a moist place. In Summer, for instance, if care be taken to choose roots about one half inch in diameter, not already withered or rotted from the effects of the phylloxera, there may be seen; after some days covering with soil, an abundant multiplication of the insects.

Accordingly, for the work in hand, tubes of metallic gauze were constructed, destined to contain fragments of roots, which could be introduced easily into the soil.

These tubes measured one and one quarter inches in diameter, and twelve inches in length; were open at the lower end, at which to put in the roots, and had a rod attached to the top to serve as a handle, and passing perpendicularly through a metallic plate, the rod being twelve inches long. The whole was so constructed that, when fixed in the ground, it would descend to a depth of twenty inches, the horizontal plate guarding against the admission of water, unnatural packing, pressure, etc. The handle carried in addition a zinc tag, on which was marked a number to facilitate its recording.

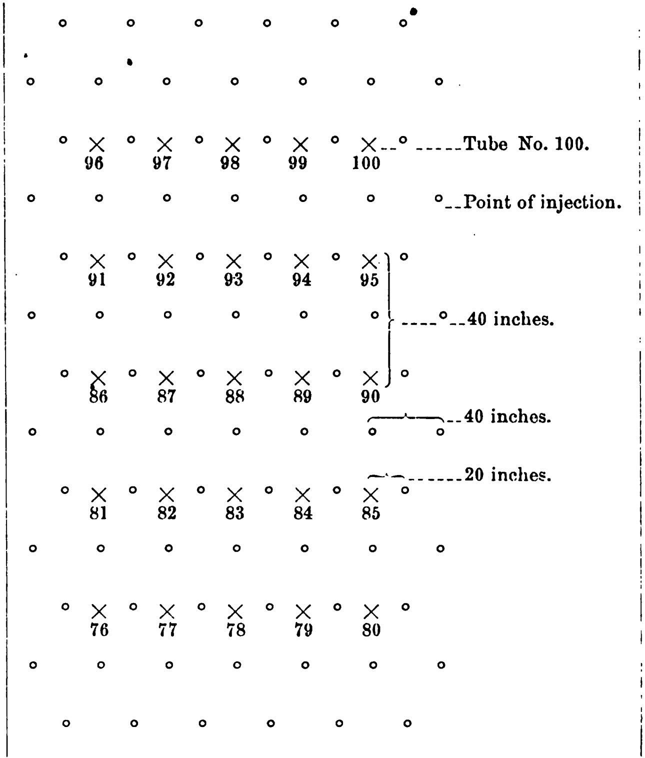
To experiment, a number were forced in to the desired depth, at distances to accord with the desired results. In filling the tubes with roots, care was taken that each fragment should be covered with phylloxera, thus representing the unit on which the results were to be calculated. In planting the tubes the earth was replaced about them in its natural condition, and some days after the field treated as if each tube represented a vine.

There is realized by this method a practical example, productive of accurate results. Each tube represents, not the whole vine, but only its main root; that is, the portion most distant from the injected substance. After a proper interval, differing in the different experiments, the tubes are withdrawn and the roots contained examined. The following will well exemplify the method.

EXPERIMENT MADE ON THE EIGHTEENTH OF OCTOBER—GRAVELLY SOIL ON A GENTLE SLOPE.

On the eighteenth the tubes numbered from seventy-six to one hundred were planted forty inches apart, in squares, and were treated with carbon bisulphide, injected at the rate of sixteen grams to each tube, placed in two holes to each square (about two to each one and one fourth square yards of ground); temperature of the soil, 68° F.

PLAN OF OPERATION.



On the thirty-first of October, the tubes were examined with the following results:

Tube No. 76, containing 13 pieces of roots.—Dead and decomposed on some of the roots.
Tube No. 77, containing 10 pieces of roots.—Dead and decomposed on some of the roots.
Tube No. 78, containing 7 pieces of roots.—Five living on one single root.
Tube No. 79, containing 9 pieces of roots.—Dead on one root.
Tube No. 80, containing 8 pieces of roots.—No trace left.
Tube No. 81, containing 8 pieces of roots.—Six living on one root.
Tube No. 82, containing 11 pieces of roots.—No trace left.
Tube No. 83, containing 10 pieces of roots.—No trace left.
Tube No. 84, containing 10 pieces of roots.—Dead and decomposed on three roots.
Tube No. 85, containing 13 pieces of roots.—No trace left.
Tube No. 86, containing 8 pieces of roots.—No trace left.
Tube No. 87, containing 10 pieces of roots.—One living and laying eggs, several of which were to be found on the root.
Tube No. 88, containing 9 pieces of roots.—Dead and decomposed on three roots.
Tube No. 89, containing 6 pieces of roots.—None left.
Tube No. 90, containing 12 pieces of roots.—None left.
Tube No. 91, containing 12 pieces of roots.—None left.
Tube No. 92, containing 11 pieces of roots.—Some living on three roots.
Tube No. 93, containing 10 pieces of roots.—Some living on three roots.
Tube No. 94, containing 6 pieces of roots.—Some living on three roots.
Tube No. 95, containing 10 pieces of roots.—None left.
Tube No. 96, containing 9 pieces of roots.—Dead and decomposed on five roots.
Tube No. 97, containing 9 pieces of roots.—Some living on four roots.
Tube No. 98, containing 11 pieces of roots.—Alive on eight roots.
Tube No. 99, containing 10 pieces of roots.—Alive and many eggs on four roots.
Tube No. 100, containing 12 pieces of roots.—Dead and decomposed on five roots.
Total number of roots, 244; number still carrying living phylloxera, 30.

By means of the numbers 244 : 30, the actual energy of the insecticide is represented. Applying the simple rule of three, it is seen that some insects on a fraction over twelve out of each hundred roots resist the insecticide, while from the remaining roots they have been completely removed. To this number, twelve, the term *coefficient* of the insecticide is applied; it being deemed more advisable to apply it to the number on which they are spared than to the number on which they are totally destroyed.

Another lot of tubes, planted in another piece of the same soil, and receiving no treatment, were withdrawn simultaneously and on these the phylloxera had multiplied to a considerable extent, proving that all reduction made on the other roots was entirely due to the action of the vapor.

Experiments similar to the above, when made in Winter, became difficult because of the inactivity of the insects and their change in color, but this was overcome by leaving the tubes in the ground for fifteen or twenty days after the application, at the end of which time the dead pucerons became decomposed.

The experiment made on the eighteenth of October was repeated a few days after, on a piece of ground which, owing to its location, afforded scarcely room enough to plant the twenty-five tubes forty inches apart. The outside rows of injections (two in the former experiment) became in this only one. The coefficient found was eighteen in place of twelve. Examination of the tubes proved that all but one of the roots on which the phylloxera survived were in tubes on the outside rows, and the one exception was in a tube next to the border row. This phenomena is explained by the conditions occurring in the absence of the outer row of injections. The diffusion of vapor from the marginal injection is evidently more active than that in the center, where met with the tension of surrounding vapors. On the borders, consequently, the energy of the vapor is rapidly reduced. By adding another row of injection on the outside, these conditions are altered to agree with that of the center of the square. It is now clear, that in treating a number of vines, it will be necessary to treat out and beyond the infected spot. Vines planted in rows wide apart, each row becoming a border as above, should receive treatment beyond the extent of the roots in the rows.

Throughout the numerous experiments made as above, the tubes in which the phylloxera survived the treatment served to confirm the theory of the more ready diffusion of the vapor on the outside row. It was also noticed in subsequent experiments, that where made on the ground that had already been several times pierced by the tubes, injectors, etc., the coefficient increased, showing that the tubes formed chimneys or escapes for the vapor. This was further exemplified in one case in which a portion of the square treated had been formerly pierced, and on this portion appeared a great deficiency in the results. It is well to state here, that experiments made in recently cultivated ground produced uncertain results, from which is to be inferred that, in the application to vineyards, the treatment should never immediately follow cultivation, but only after the soil has settled back into its normal compact condition. The same applies in part to subsequent work. The treatment should not be followed by cultivation so soon as to hasten the reoperation.

As one of the results of this study of the diffusion of carbon bisulphide, it is concluded as necessary to avoid cultivating the soil within less than six days from the time of the finishing up of the treatment.

At this point experiments were made by mixing carbon bisulphide with other material, to determine the coefficient in this form. The results proved not quite so favorable as by the carbon bisulphide when used alone, yet valuable in a degree.

In the following tables may be seen some of the most important results acquired in this work by Professor Marion, and permits of a fair comparison of results from single treatment and those by double treatment:

TABLE NO. 1.

Experiments made with Carbon Bisulphide to determine the energy as an Insecticide of different doses, when the Treatment consists of a Single Application.

Distance between the Tubes—inches.	Quantity of Carbon Bisulphide in Grams.			Coefficients.	Time of Experiment.	Observations.
	Per Hole.	Per Tube.	Per Sq. Yd.			
40	7	14	10	17.00	July	
40	8	16	13	12.32	October	
40	10	20	16	8.97		Mean of 5 experiments.
40	10	20	16	6.25	September	
40	10	20	16	9.09	December	
60	9	45	16	8.38	December	
28	9	18	29	1.63	August	
28	9	18	29	4.40	November	
28	9	18	29	3.51	Aug. & Nov	Mean of 2 experiments.
40	20	40	32	1.00	Aug. & Oct.	Mean of 2 experiments.
24	10	20	44	0.00	August	

TABLE NO. 2.

Experiments made with Carbon Bisulphide to determine the energy as an Insecticide of different doses, when the Treatment consists of a Double Application.

No. of days betw'n the two applications.	Quantity of Carbon Bisulphide in Grams.				Coefficients.	Times of Experiments and Observations.
	Per Hole.	Per Tube.	Per Sq. Yd.	Total quantity employed in two operations.		
–	5	10	8	20	1.20	Mean of 5 experiments.
3	5	10	8	20	1.30	August.
3	5	10	8	20	0.00	November.
–	6	12	10	24	0.97	Mean of 3 experiments.
4	7	14	11	28	0.00	August.
4	7	14	11	28	0.83	December.
5	8	16	13	32	0.00	October.
5	10	20	16	40	0.00	October.

It may be observed, in Table No. 1, that concerning the resistance of the vine to the vapor, the effects are always proportional to the quantity of bisulphide employed for each square yard and not to that for each tube or for each vine. For example, the destructive effect on the insects is comparatively small with forty-five grams per tube; in which case, as may be seen by the table, the coefficient is 8.38; while it is complete with twenty grams—coefficient, 0—this is because the first is sixteen grams per square yard, while the second is forty-four grams per square yard. Other similar comparisons may be drawn from Table No. 1. Attention is called to this because of the common tendency to calculate on so much per vine, losing sight of the necessity of a uniform density of the toxical atmosphere throughout the soil treated without allowing injury to the vegetation. Pursuant to the same, it may be remarked that the effect is not governed by the quantity injected per hole, but that the quantity and the number of holes should vary with the quantity per square yard. It is well to observe further that the latteral roots of the vine, which are not present in the above, would, by their close proximity to the holes, change somewhat the final results.

Finally, the most important fact gathered from Table No. 1 is the decrease in the coefficient with each increase in the quantity of sulphide per square yard. It is impossible to discover any absolute proportion between these, because so many elements enter to influence the result. One thing is evident, viz: that the quantity should be made to vary to suit the case in hand. It has been prominently observed that the tubes where the destruction is complete, and those where it is partial only, are usually grouped together, proving that penetration by the vapors is more difficult at some points than at others, and that the soil being more or less heterogeneous, plays an important part in practice.

In these experiments the effects of moisture in the soil have not been sufficiently marked to permit of rules being deduced. The coefficient obtained in December are such as to indicate a decrease in the energy, which may be due to the fact that the hibernants, in which respiration is almost suspended, resist better the toxical vapor. In subsequent experiments, however, it has been noticed that even the hibernants have been completely destroyed by the repeated application of thirteen grams per square yard. Any less effect in Winter would be compensated by the greater resistance of the eggs at other seasons; in fact, it has not been rare to discover in Summer, eggs on pieces of roots from tubes in which all of the insects had been destroyed.

The single treatment has succeeded in completely exterminating the parasites only by the use of quantities exceeding forty-four grams per square yard. Now, healthy and vigorous vines will support this large dose, and with such it may enter into practice; but exceptional cases are as well the subject of this discussion. The smaller doses—that is, thirty-two grams and twenty-nine grams, usually furnish very low coefficients, but never total destruction.

In the table of the repeated applications, the distances apart of the tubes have been intentionally omitted, as all were the same, namely: forty inches. In this table there is to be found, in addition, the length of the interval, and the total quantity injected in the two applications.

The advantages of the double treatment, or repeated application, become apparent at first thought. The second introduction of vapor into the soil before the first has ceased to act lessens the irregularities which might be produced by a heterogeneous soil, and renders the penetration more uniform. The irregularities in density of the vapor at a point distant from the point of injection are much lessened, and those of the phylloxera, which may survive the first application, are quite certain to succumb to the second. It also lessens much the possibilities of survival by its long continuance—a result claimed for mixtures of bisulphide with coal tar and other materials, which, however, the sulphide surpasses, inasmuch as the former gives forth the vapor with great irregularity.

A proportional decrease in the coefficient is obtained with the increase of the total quantity per square yard. One experiment with sixteen grams, in the month of November, formed an exception in giving a coefficient of zero, which coefficient seems usually to belong only to doses of twenty-six to thirty-two grams; however, this unfavorable result is corrected in others which raise the mean to 1.21. In December the coefficient 0.83 was obtained with twenty-two grams, while this dose again in August gave zero; here again may it be inferred that the hibernants resisted better, which resistance, as proved by numerous experiments, can always be overcome by twenty-four and twenty-six grams per square yard. It becomes particularly valuable to make comparisons in the two tables. For example: the experiment with sixteen grams in the single application, and the same in the double application. For each of these a mean of experiments was obtained, in which, for single application, the mean coefficient was 8.97, while it was only 1.21 for the repeated application, and this difference is considerable. The repeated application overcomes the liability of mistake in the work—inaccuracies in the first application are overcome in the second, a spot overlooked or omitted in the first would receive the second, in which, if the treatment were the single one, this spot would escape treatment. This is one of the greatest advantages of the repeated application.

Finally, it is seen that twenty-nine and thirty-two grams per square yard give, in a single application, a poor coefficient, which can be compared only with those of nineteen and twenty-two grams where distributed between two operations. Total destruction is often the result with the former, and in no case does the coefficient get up to unity, while with twenty-six grams, the usual dose, and with the exceptionally large dose of forty grams, in two applications, the total destruction of the insects is accomplished. The extermination of the phylloxera which can be depended upon only when forty-four grams are applied per square yard, if in single application, is often accomplished with sixteen, nineteen, and twenty-two grams, employed in repeated applications—always with twenty-six and thirty-two grams per square yard. On these facts it is not difficult to base calculations—whether or not the additional labor necessary for a second application is not compensated for in the diminished quantity necessary and the greater certainty of the complete extermination and avoidance of error.

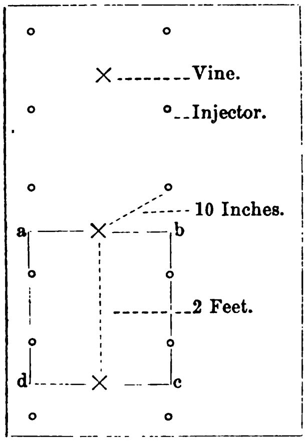
It will further be seen that the resistance of vigorous vines to the vapors permits the employment of twenty-six and thirty-two grams per square yard without injury.

RESISTANCE OF THE VINE TO THE ACTION OF CARBON BISULPHIDE.

In the first use of carbon bisulphide, experimenters met with the difficulty of injuring the vine in applying sufficient to destroy the aphidians. Misapprehensions, not completely overcome to the present day, grew out of these experiments. Later, the employment of feeble doses proved that it was not impossible to conciliate the two requisites of the problem, viz.: to kill the insects without killing the vine. It is readily understood that if the quantity be too feeble it is inefficacious against the phylloxera; and, on the contrary, if a certain dose be exceeded the vegetation is endangered. The fear of this last deters many vinegrowers from applying bisulphide to any but those vines already badly reduced. In such cases unsatisfactory results may often be the expected consequence.

Many vinegrowers, in first using the sulphide, committed the error of putting a large quantity immediately at the foot of the vine, ignoring the extensive system of roots which might be infested a number of feet from the part treated; that this should injure the vine, too, is no wonder, being so excessively strong at the point most susceptible.

As an example of this mistake an experience at Sainte-Foy-de-Lorgues (Var.) is given. The vines are two feet apart, in ranges six and one half feet apart. At the first application four holes were made about each vine, ten inches distant, measured on the diagonal, as shown in the following scheme:



The geometrical calculation shows that if the holes are ten inches from the vine, and they are regularly disposed, they must form a square whose side is fourteen inches. Each vine can then be considered as occupying in surface a rectangle (a, b, c, and d) of twenty-four by fourteen inches, or three hundred and thirty-six square inches, in which the distribution of the sulphide is uniform and maximum. Six grams were allowed to each hole. Now, if it be remembered that each dose introduced into one of the holes is diffused in equal proportion throughout the rectangle, a, b, c, d, and without, it will be seen that each of these surfaces have, in reality, received twelve grams of the liquid, which becomes, by calculation, over forty-six grams per square yard, in which case it is not surprising that fifteen per cent. of the vines treated were killed.

This forms a very instructive example from which to calculate the best arrangement of the holes about the vine; it results that the subterranean diffusion of the vapor will vary greatly with the arrangement of the holes. In consequence, the action on vegetation may be very energetic, even with six grams per injection.

To avoid mistakes of this kind it is always necessary to base calculations on the surface treated, and not on the number of vines contained. This method only will insure complete work, for in the above case, there continued to exist living insects in the intervals between the ranges. Thus, when the question of quantity arises, it is necessary to calculate on the amount per square yard rather than the amount per vine.

Aside from these considerations, there is exposed a fundamental fact which elucidates the whole question of the resistance of the vine to the sulphide. In this vineyard, at Sainte-Foy-de-Lorgues, it is observed that, in spite of the excessive quantity, fifty grams per square yard, the proportion of vines which have perished is quite small.

At Solliès-Pont (Var.), in the vineyard of Mr. Gueit, the mortality of the vines reached twenty-three per cent., although the dose of sulphide did not exceed in some places twenty-eight grams per square yard. In explanation of this result, aid is derived from an adjoining vineyard, in which the same workmen operated in the same manner, the soil being the same also. In the latter there were scarcely any vines killed. A single difference in these vineyards explains all. That of Mr. Gueit had been long infected, and the vines were badly reduced before the treatment; while the other, belonging to Mr. Jeansolin, at the beginning of the treatment, showed but few vines nearly dead. From this it becomes evident that the initial weakness of the vines is most important in rendering them susceptible to the sulphide. In the employment of large quantities of sulphide this truth becomes evident; there is, however, a need of establishing it by scientific investigation; not only is it necessary to divide the vines into two classes, strong and feeble, but it becomes further necessary to determine in both cases the degree of their resistance, and to determine the nature of the injurious action of the vapor.

In making the application, it is frequently observed that by placing the barrel of carbon bisulphide in a vineyard, two or three vines nearest the barrel begin to wilt; these are the ones which receive directly jets of vapor each time the workmen fill their injectors, it is therefore generally believed that those vines which perish at other points of the field operated upon have been effected in an analogous manner; that is, that the emanations of vapor from the soil impregnated with the sulphide withers the leaves. It is important to determine if this be so, and whether the injury is really produced by action of the vapor on the roots, or on the foliage of the vine.

To experiment, some full bunchy vines were sprinkled with the liquid bisulphide, which would operate as vapor coming from the open holes made by the injector. No one of these exhibited signs of grave effects, only the leaves sprinkled and touched by the liquid were killed, and, singular as it may seem, of those portions not struck by the liquid, some of them continued green and healthy, while others withered rapidly. To complete the experiments vessels containg twenty grams of sulphide were disposed beneath the vines, and left to evaporate under the foliage situated from twenty to twenty-four inches above them—not a single leaf suffered. Finally, a double row of vines was treated with an injector in the ordinary manner without, however, covering the holes, into each of which ten grams of bisulphide had been placed. The single phenomena noted here, was the wilting of a few leaves in immediate contact with the orifice of the hole.

All of these experiments were made near the end of the month of June, at a time when the evaporation is very active; the conclusions allowable, were—not that the vines were absolutely inocuous in their foliage—but that prolonged contact of the vapor was necessary to produce any deterioration. With ordinary conditions, when the holes have been closed more or less tightly, and even when several of them remain open, the natural currents of air are sufficient to dissipate whatever vapor may rise from the holes. Admitting the concurrence of a number of unfavorable circumstances, such as the presence of numerous tender shoots—undoubtedly more sensitive—the excessive multiplication of the holes, the abundance of liquid in these holes (all of which circumstances never concur); even then the vine will seldom succumb entirely. It is well to avoid cases of this kind where the first branches are scarcely started. It can be announced from what is to come, that if there be any poisonous action resulting to the vine, it must come through the effect of the bisulphide on the roots.

It is necessary to understand, further, whether the suddenly manifested depression of the vine comes from the simple arrest of the functions, or by a system of general poisoning by absorption of the toxical principal. The latter is little probable, nevertheless it becomes necessary to prove it experimentally, for it is of interest and of value to know whether the vine affected is irrevocably lost, or if, life continuing in its tissues, after a temporary suspension a recovery may be had. Recent cases have proved that the so called *resurrections* are of frequent occurrence. The proceeding to set aside the hypothesis of poisoning, consists at first in introducing directly the liquid carbon bisulphide into the wood of the stump. To effect this holes were made in a number of vines with a gimlet, and four or five grams of the sulphide introduced into each of these holes; they were then plugged and sealed with gum lac, insoluble in the sulphide. This operation was performed on seven or eight different vines. On still another vine a large root was unearthed and cut; the end, still connected with the vine, was introduced into an experimental tube containing fifteen grams of bisulphide; the orifice of the tube was closed and sealed to prevent any escape of the liquid, then the whole was again covered with earth.

Not one of the vines so treated gave any signs of suffering or enfeeblement; however, in examining the root plunged into the sulphide, it was noticed that the liquid had completely disappeared, and that the tissues at the end had been completely decomposed, and for about two inches rendered friable. The former vines were similarly affected in a portion of the wood about the gimlet hole, suffering an alteration in the tissue.

All of these facts concur to prove that the injury done by the sulphide is always local, even on the branches it is so; and when it is stated that the vine is restrained in all its organism, it is meant that those parts attacked by the too abundant vapors which impregnate the soil, suspend temporarily their absorbing functions, and thus arrest for a time the life of the plant.

Another experiment of the same order, and no less conclusive, was conducted on six vigorous vines, side by side in one of the double rows of a vineyard at Cap Pinède; two or three of the most vigorous roots on each were laid bare and lacerated longitudinally at some distance from the vine; these were then watered with about eighty grams of sulphide to each of the six vines. Five days after there was a noticeable suffering in each of the six plants; the tender shoots were withered, and nearly all of the leaves were yellow, depressed, and curled on the middle vein so as to expose the lower surface; some of these leaves continued to wither and fall, but about the tenth of July, seventeen days after the application of sulphide to the roots, three of the strongest vines manifested no further sign of suffering, the leaves resumed their natural condition and size, and the vines were only to be distinguished from vines not operated upon by a paler color. Concerning the remaining three vines, they were not completely revived until about the eighteenth.

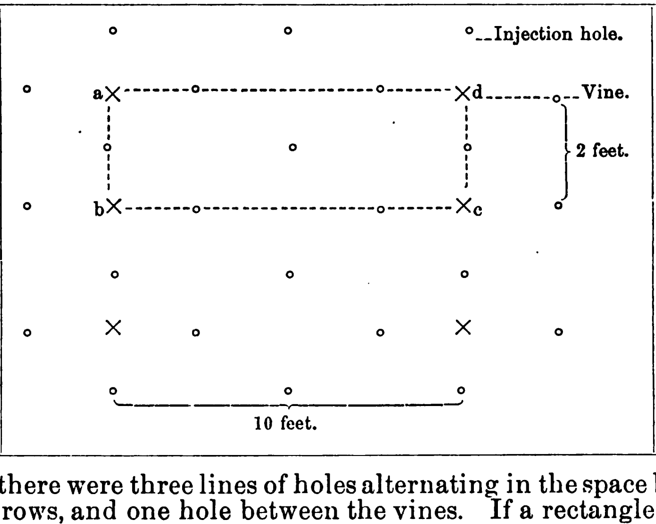
In repeating the above experiment in another vineyard, it was found that the revival of the vine was considerably hastened by watering some days after the above treatment.

Combining all of the foregoing results, it is seen that there is no poisoning, and that the general depression of the vine is not attributable to the introduction of sulphide into the tissues of the plant, but to the prevalence of vapor diffusing upwards and coming in contact with the foliage.

The nature of the injury to the root tissue is fully shown by the microscope, which also explains the exterior phenomena. The functions of the roots being suspended, the flow of the sap is arrested, and, as the breathing continues in the green parts, a consequent depression in these parts results also. Incident to the lack of water produced by this, the processes of reduction carried on and furnished by this liquid are interrupted, and the chlorophyl processes are arrested, and the pale tint appears. If this state continue long, the suspension will become fatal; but the vapors of the sulphide disappearing from the soil, the roots beginning to act, and the moisture being drawn into the leaves again, the normal state of the vine becomes reëstablished.

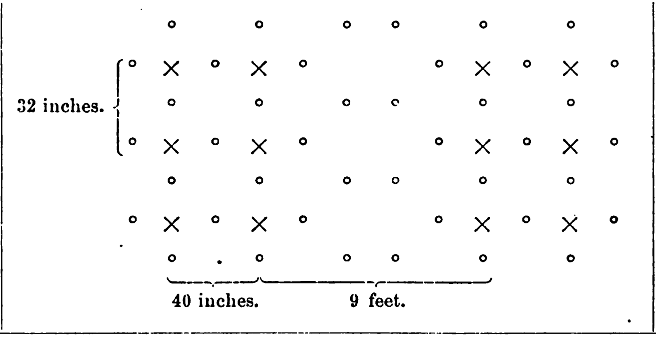
It is readily seen now how irrigating serves to hasten this regenerative process; why the vines affected return to their former state of luxuriance; and why strong vines, the tissues of which are full of sap and nourishment, can support without inconvenience the temporary suspension in the absorption of moisture, while those vines already nearly destroyed by phylloxera, and of which the tissues are already exhausted, resent particularly the presence of the vapor about the roots.

There remains but to expose, in detail, the experiments made to determine the injury to strong and feeble vines. The resistance of feeble vines was determined at Creissaud, at Mr. Olive's, in the part of his vineyard most reduced by phylloxera. A few rows of four-year-old vines were chosen, and also some thirty and forty years old—all of which were suffering, and among which there were already many dead vines. It became interesting to know if the average dose ordinarily prescribed for vineyard treatment could be endured by plants in such an advanced state. The old vines were two feet apart, in rows ten feet apart. The injections were made as represented in the following figure:



Here there were three lines of holes alternating in the space between the two rows, and one hole between the vines. If a rectangle be constructed (a, b, c, d,) having for its corners four nearest vines, it will inclose the space occupied by each vine, which is twenty square feet, and which received four injections of 11.43 grams of sulphide of carbon. Each vine has accordingly received 45.72 grams, and each square yard 20.57 grams.

The young vines were thirty-two inches apart, in double rows forty inches from each other, the distance between each double row and the next being nine feet, the holes were distributed as follows:



In this, the surface occupied by each vine is 16.44 square feet, and the quantity of bisulphide applied with the same instrument reaches about forty grams for each of these spaces of 16.44 square feet, which corresponds to 21.84 grams per square yard.

The operation was performed on the twenty-sixth of June, 1877, the vines being numbered and an account of their initiatory condition kept.

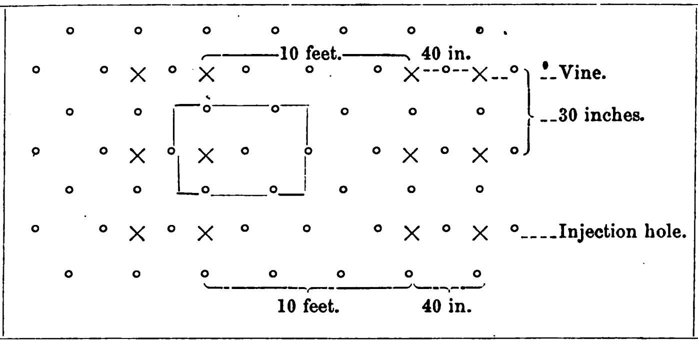
Of the old vines, twenty out of seventy-two which were put through the treatment, without being utterly devoid of shoots were, nevertheless, on the verge of dying; among the others, scarcely ten were found in ordinary condition. Of the young vines, seventy-two out of one hundred and fifty were completely stunted, forty-six a little less affected, and thirty-two possessing still some vigor. The results of the application of sulphide were the same throughout the two vineyards. About the third day after the treatment, and continuing seven or eight days, there was a yellow appearance observable in the leaves, except on the vines relatively strong, and a few in each field which had before been withered, a dozen of which might be counted in each vineyard. About the twelfth of July, all those not too badly struck, recovered their green color, and recovered from the enfeeblement produced by the vapor. At this moment, however, a remarkable difference occurred in the two fields; while the young vines which had not been completely suppressed continued to vegetate in good condition, the old vines declined more and more. This fact would appear inexplicable were it not that the other ones in the same rows which had received no treatment were observed to droop and wither still more rapidly.

The phenomena observed in this experiment teach that those vines already badly weakened, have to fear the injurious action of the bisulphide as ordinarily applied in practice. As their value is inconsiderable, it is not generally necessary to consider them in the treatment of the phylloxerated vineyard, where they are found only in the bad spots or centers. In rare cases, where the vineyard is thus enfeebled throughout, it is well to make uniform distribution throughout the soil, and to reduce the dose slightly; bearing in mind, however, that the vines relatively strong, which did not suffer in this experiment, were already so reduced as to have ceased to bear grapes. It further appears from this work that, other things being equal, young vines support the vapor better about their roots. Another assertion may be made on these results, viz: it is certain that with the ordinary doses the proof is terminated in eight or ten days.

Observations made heretofore concord perfectly with these. The results stated in experiments on diffusion and demonstrating the persistence of the vapor in the soil, confirms these results; consequently, when the vines are seen to die a few months after the period of treatment, it is not right to attribute it to the sulphide; the vines were weakened and would have perished before, if abandoned to themselves.

At Cap-Pinède experiments were made in that part of a vineyard appearing most vigorous. They had suffered a great deal from phylloxera until 1876, but beginning with 1877 sulphide was applied, and under the influence of a suitable fertilizer, the growth became, in some places, very flourishing. In June they presented a beautiful appearance; they were then submitted to the usual dose of sulphide, and this increased to the limit of resistance of the vines, that is, as indicated by experiment. The increase was obtained by introducing ten, twenty, or thirty grams into each injection by giving two or three strokes of the piston of the injector in the same place.

The rows were all similarly disposed (the same figure answering for the three experiments). The interval between the double rows was ten feet, and the distance between the two lines constituting a double row was forty inches; the vines in these lines were thirty inches apart. The following is the figure applying to the three cases:



It is seen from the above that each vine occupies a rectangular surface of 16.66 square feet, each of which spaces received four injections. Ten grams per hole gives forty grams per vine, and 21.36 grams per square yard; twenty grams per hole gives eighty grams per vine, and 42.72 grams per square yard; and thirty grams per hole gives one hundred and twenty grams per vine, and 64.08 grams per square yard. These operations were conducted at the same time as those at Creissaud, so that the results might be comparable under identical atmospheric influences. In these, also, each vine was numbered, and its previous condition noted and recorded. For the weakest dose (21.36 grams per square yard) the row of poorest vines were selected, among which only one was found so reduced as to have stopped bearing, and this had short stunted canes. Eight days after the operation it was completely withered, the others showing no injury, nor even alteration in color; very few leaves drooped. After twenty days, the poor vine commenced putting forth new leaves.

The double row, receiving 44.24 grams per square yard, possessed an exceedingly singular appearance before the treatment; some very flourishing, by the side of which were seven or eight vines without any grapes, and having only short sickly branches. It is well to note, however, that compared with vines like those of Creissaud, these would have been considered very fair. On the twenty-eighth of June, five days after the operation, a pale tint became perceptible throughout the whole row, and they appeared sensibly enfeebled and depressed. Of the whole one vine, the weakest, showed wilted leaves, on five others of the same category a yellow color appeared. On the second of July the difference between the feeble and strong vines was striking; the latter had completely acquired their former color and could not be distinguished from the neighboring vines not treated; the others continued to suffer, and three of them dried up completely. Those which had not lost all of their color, but had shown marked enfeeblement, dropped a few of their leaves, and strange as it may seem, on two or three bunches of grapes the terminal grapes wilted and shivelled, and underwent a premature ripening. This phenomena appeared on all of the vines submitted to a heavy dose. About the thirty-first of July those vines appearing dead had put forth new branches.

The double row, which received 64.08 grams per square yard, offered at first the same singular aspect as did the former ones, but altogether the condition was better. The yellow color came on quickly, was more intense, and continued until the tenth of July, sixteen days after the treatment; the drooping passed from the leaves to the tender branches; many young shoots withered, some even on the most vigorous vines. Those of medium strength lost many leaves, and later the grapes were seen ripening on completely naked branches. The five weakest vines dried up entirely.

Finally, on the eighteenth of July, twenty-four days after, the yellow color had entirely disappeared from the strong vines, continuing on the others up to the thirtieth. At this date the spot treated could be distinguished from the surrounding vineyard only by the clear space produced by loss of leaves from the branches. One of the five vines which appeared to dry up completely issued new shoots.

It is not necessary to increase the quantity in experiment any farther. It is certain that sixty-four grams per square yard will never be needed or recommended for use, as much less is sufficient to destroy the phylloxera.

The damage done to the vegetation by treatments of this nature, although temporary, is not the less important, and should be lessened in degree as much as possible. With forty grams per square yard the risks encountered are incomparably less, and when the vegetation is good this quantity can be applied if a large dose be desired.

This last might be thought necessary when, for example, the whole country about the infected spot was exempt from disease. There would then be no reason why this dose should not be applied, costly though it may seem, because the spot infested is so small and the treatment more sure to produce complete vanquishment of the parasite.

The foregoing results are based on experiments and verified by practical work in the field. The perfectly graduated effects corresponding to the different quantities of sulphide employed, permit of there being definitely established the distinction between strong and feeble vines, and, when there exists any doubt about the quantity which may be used with safety, there is security in following within the limits prescribed by these experiments.

It should be further stated that in determining the resistance of the vine to the bisulphide administered in a double application, doses varying from sixteen to twenty-four grams per square yard were applied at Roucas Blanc, in the vineyards of Planque, during July. The vines were first carefully numbered and their initiative condition recorded. In spite of the advanced state of the vegetation, the repeated application, with only three days interval, and with a dose of twelve grams per square yard in each of them, seemed only to accelerate slightly the natural drying up of the leaves at their proper time. This was attested only by a neighboring row of vines which had not been treated.

The action of the sulphide vapors on the organs of the vine were not studied, it being only reasonable to suppose that at this time, when the organs of absorption were at rest, much less injury could be effected than would result in Summer.

EXPERIMENTS WITH CARBON BISULPHIDE IN CALIFORNIA.

The first experiments with carbon bisulphide in destroying the phylloxera in California, were made as far back as 1875, by Dr. Jas. Blake, of Calistoga, formerly of Sonoma Valley. These experiments were in original researches, prosecuted by the Doctor at the request of the Buena Vista Viticultural Society. We take the liberty of quoting the following from a letter addressed to the chief executive viticultural officer of this Commission, November, 1881:

> The disease was already showing itself in the Buena Vista vineyard, after having destroyed the vines in some neighboring vineyards. I visited the place and had some of the affected vines dug up; following down the roots as far as any trace of the insect would be found, which, in some cases was more than four feet below the surface, although, as a general rule, even in badly affected vines, the insect was not found at a greater depth than three feet.
>
> In view of the fact that the insect had already established itself at a depth of four feet from the surface, the chance of reaching it by any liquid insecticide seemed hopeless. The inutility, if not even the absurdity, of attempting to eradicate the disease by the use of liquid insecticides will be apparent when we consider that an inch of water on the surface represents a quantity of one hundred and thirteen tons to the acre. When our ground is dry an inch of rain only moistens the earth about three inches from the surface, and even in moderately moist ground it would be useless to employ less than four inches of any liquid, or four hundred and fifty-two tons to the acre, with any chance of its reaching the depth of four feet.
>
> I was thus led to experiment with the underground application of bisulphide of carbon, as, owing to its volatility, I thought that the vapor might permeate the ground sufficiently to reach the lowest roots of the vines, and that in a state strong enough to destroy the insects without injury to the roots. An instrument for applying it was made by taking a piece of one inch iron gas pipe about four and one half feet long, closing the lower end by a pointed piece of steel, boring some small holes near the lower part of the tube, and having the inside of the pipe smooth

so that a piston would work in it. The pipe could easily be forced into the ground to a depth of two feet.

I think it was in March, 1876, that the bisulphide was first applied to some vines that evidently were badly diseased, and on the roots of some of the same patch that had been dug up, on which the phylloxera was found at a depth of four feet from the surface. The bisulphide was applied in three places around each vine, at a distance of about two and one half feet from the vine. Half an ounce to three quarters was introduced into each hole and the treatment was repeated after about a week. I think about three hundred vines were treated from March to May. In July I had a number of the vines that had been treated taken up, and found that on nearly all of them the insect had entirely disappeared—one or two patches only being found on the deepest roots of two vines—and, as the vines were twelve years old, the roots were down more than four feet. At this time, some of the vines that had been treated were improving in appearance, others were apparently about the same as the untreated vines, and some on which the bisulphide had been used more than twice were evidently suffering from the treatment. A severe accident prevented my following up my experiments, but it had become plain that the bisulphide, used in this manner, was evidently capable of controlling the disease.

No further record is had of experiments with carbon bisulphide in California until during the past year. When the phylloxera was found in counties other than Sonoma, the alarm was started, and again arose the demand for a remedy. This time it met immediately with the production and preparation, for this purpose, of carbon bisulphide, which, at that time, according to French authorities, appeared to answer the requisites of a remedy. On November 6, 1880, it was recommended by the St. Helena Viticultural Society to vinegrowers as the best and most efficient means of destroying phylloxera known, and was subsequently similarly commended to the public by the Board of State Viticultural Commissioners, and in consequence was applied in several vineyards during the ensuing year.

The use of carbon bisulphide was last year delayed four months after the above indorsement, awaiting the arrival of an injector, to be of the latest French improvement, which had been sent for to France by the manufacturer of carbon bisulphide, it being desirable that the first applications should encounter no difficulties resulting from imperfect apparatus. Arriving in March, the first application was made in this month in Mr. J. C. Weinberger's vineyard, near St. Helena.

The phylloxerated spot here treated consisted of about one half of an acre, which, to all appearances, had been infested for four years. The vines attacked were mostly *Muscatels;* remainder, *Reislings*, growing on rather a steep hillside, with southeastern exposure, on quite rocky and poor soil.

At the time of the application, the soil was in such a condition as to render the application easy and rapid. The vines were six feet apart, and the rules for this distance, as given in the tables accompanying this work, were followed closely. Two treatments were had, the oldest and worst spot receiving the death treatment, and the remainder the curative treatment; both being treatments made by repeated applications of the liquid, with an interval of six days between. For these, the quantity, as given in the table, was at the rate of twenty-six grams per square yard for the curative treatment, and forty grams per square yard for the death treatment. The work of applying was guarded carefully against error, but, as afterwards proved, sufficient space was not included to properly circumscribe the infected spot. Many examinations by parties interested in the work followed this treatment, but all failed to discover any phylloxera where they had before been so numerous. The report of Mr.

Morse, investigator for the Viticultural Commission, made on June 13, 1881, reads as follows regarding this spot:

> Carbon bisulphide has been used as a remedy, both in death and curative treatment; the former killed but few vines and apparently all the phylloxera. No phylloxera could be found within the limits of either treatment; but just outside they were easily found, showing effectiveness of treatment, but not sufficiently extended. The roots were not vigorous, nor yet dead. They were somewhat wilted, but are now throwing out new shoots.

This vineyard proves better the effects of the insecticide than if no phylloxera had been found, being evidence that the disappearance of the insects was due to no other cause. With these survivors outside the treated spot, a reinvasion during the Summer may naturally have been expected, and on further examination of the vineyard in October, the following vines were discovered to be infested, viz: those represented in the following figure by a ×; those represented by a o were examined and no phylloxera discovered on them. It should be stated, however, that immediately after discovery of the insect without the spot treated in March, the discovery being made on the sixth of June, a single application was made with a heavy dose to the then infested vines. This treatment was irregular, being applied about the weak looking vines and not comprising a regularly defined extent of surface. To the season, a most improper one, and the irregularity, the failure of this last treatment may be ascribed.

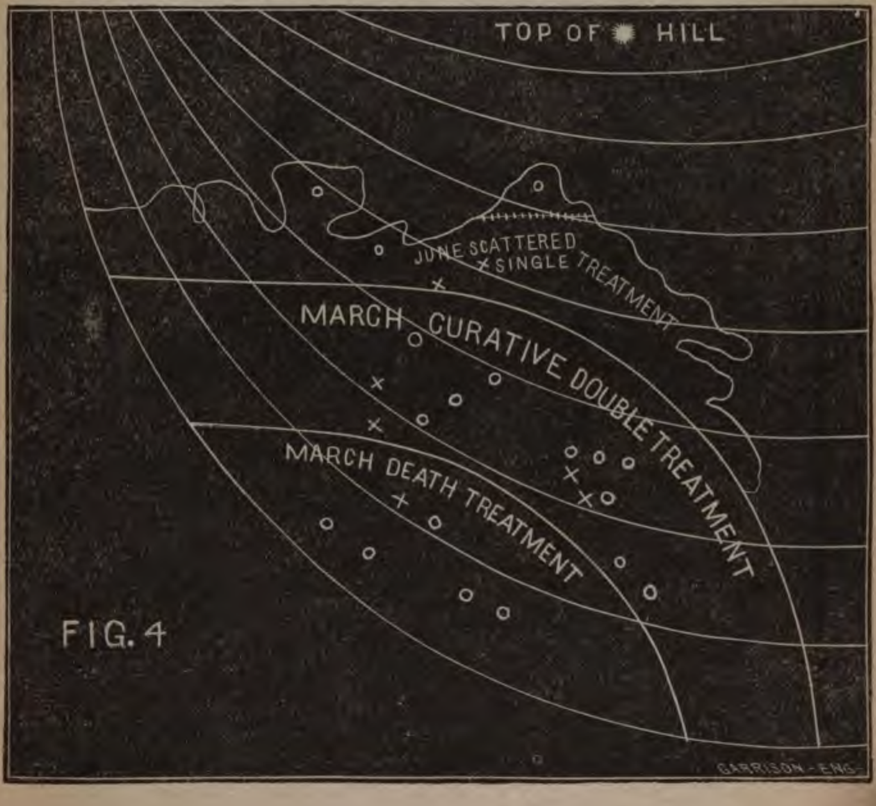

TOP OF HILL
JUNE SCATTERED SINGLE TREATMENT
MARCH CURATIVE DOUBLE TREATMENT
MARCH DEATH TREATMENT
GARRISON-ENG.

FIG. 4

From the above figure it may be seen that the following proportions exist in the vines examined, viz:

TREATMENT.	Free.	Infected.
Death treatment—March	5	1
Curative treatment—March	8	4
Curative treatment—June	4	2
Totals	17	7

Or we have seven out of twenty-four infested in October. This by no means indicates that these proportions of the whole spot treated were at this time infested; for, in searching for the insects, those vines of the most suspicious appearance only were examined. The death treatment shows very satisfactory results, in there having been but one vine found infested out of six growing and suspicious appearing ones.

The particulars of this treatment are given quite full in a report by Mr. Weinberger, made to the Secretary of the Board of State Viticultural Commissioners, which reads as follows:

ST. HELENA, CALIFORNIA, October 2d, 1881.

John H. Wheeler, Esq.:

DEAR SIR: The application of bisulphide to my phylloxerated vineyard was made twice in March, according to your directions,[1] and once in the month of June.[2] White and Chinese laborers were employed; Chinese for making holes, and white men to use the injector.

No difficulty was encountered in making the application in March, the ground being moist and soft. The application was made according to directions, in March, but only one application in June, owing to the hardness of the ground and the consequent difficulty in drilling holes for the injector. Instead of injecting the charge of bisulphide as directed, I applied in one application a double charge.

After the Spring application I could not see any immediate effect on the plant; but, as the time came for the plants to put forth leaves, I discovered that the vines which had received the "death treatment" either failed to show life, or else the growth during the season was exceedingly slow and had a sickly appearance. The vines, however, which had only received the curative treatment came out all right, and showed no injurious effect from the bisulphide.

The effect of the double dose of bisulphide applied during the growing season (June) was, in some instances, most immediate; the leaves turned yellow, fruit shriveled, and some vines, after three days, died off entirely; some of the vines, however, after shedding their leaves put out a new growth and seemed to be recovering.

Having made no examination after the application of bisulphide, I could not say what effect it had on the insect; later examinations, however, showed that the insect had received its death blow so far as the bisulphide was able to reach it. By a recent examination (September 28th), made by Mr. Morse, he found vines which had been treated last March and June again affected by the insect. Previous examination had failed to discover any insect.

It is my opinion that wherever bisulphide reaches the habitation of the insect, sure death will follow. In some instances, especially where cultural treatment had been applied, vines showed a healthy appearance, but I could find no increase in crop. I presume another year's growth will tell. Insects were discovered near the surface, as well as deep down on the main roots.

I have great faith in the use of bisulphide for disinfecting vines; the application, however, should be judiciously made, where the preservation of the vines is expected, for, applied otherwise, it is my opinion that the vine will receive a blow from which it will scarcely recover. The application should, according to my experience, be made in Spring a few weeks before plowing commences, and while the ground is in a moist condition, as the application can then be performed cheaper and with less difficulty—the effect of the bisulphide, too, is surer and more lasting. I think, further, that a light application should be made every Spring, for it is hardly possible that every insect is reached by one or two applications.

Yours very respectfully, JOHN C. WEINBERGER.

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[1] The directions followed were the same as those given in this work.

[2] In the June treatment a single scattered and irregular application was made to those vines having a sickly appearance outside the spot treated in March.

Fertilizers, so necessary as an adjunct to bisulphide treatments, played no part in the role of the above experiments—late in the season some nitrogenous material was added to the soil, but this too late to produce even part of the good effect which might have been had by a liberal use of potash and phosphate of lime.

The moral to be drawn from the wash is, to be careful in properly cirumscribing the diseased spot; it is even well to include many rows not already showing disease about the infected spot. Had Mr. Weinberger done this, he might have avoided almost entirely the Summer reinvasion which he suffered; and any reappearance of disease in Summer might have been destroyed by a second treatment of deep roots with bisulphide, treatment of surface roots with a proper wash, and a washing of the vine stumps to destroy whatever germs of disease existed above ground. Further, if proper fertilizers had been applied sufficiently early to permit of the late rains incorporating it well into the soil, an increase of crop might have been expected. It is not, in a case of this kind, whether the treatment "pays" per acre, but it is the saving of the rest of the vineyard, and perhaps the whole district, from contagion.

From the success met with in this experiment, it is to be concluded that March forms a season eminently proper and valuable for the application of bisulphide, succeeding experiments proving that later than this is not as good, and that midsummer is not at all a fitting season.

We are able to give the results of only one other Winter treatment of phylloxera with the sulphide, and these but imperfectly, owing to our inability to obtain accurate particulars concerning it. The vineyard treated belongs to Thos. J. Reed, and is situated in Brown's Valley, west of Napa. In Mr. Morse's report on this vineyard we find the following:

> Sulphide of carbon was applied last December. A hole, three feet deep, was made with a crowbar, the sulphide dropped in and the hole stopped up. Two and one half quart bottles were used on one hundred and fifty vines.[1] [The knowledge of this treatment was not obtained until after an examination had been made. Mr. Morse's report further states:] There were very strong evidences of the vines having been badly infected, but it was only after digging around four or five of the most suspicious looking vines that I could find the insect. When found, they were four inches below the surface of the ground, in a small knot or hole in the root, very few in number. The vines had every indication of having once been infested, and looked as if the pests had since left the vines.

We now pass to the Summer treatments made in 1881. From the many favorable results obtained by Summer treatments had in France, we were led to suppose that this might prove an equally favorable season in California. In this, a mistake was made. First, the want of rain in California during the Summer alters the conditions to such an extent as to render the penetrating of the soil by an injector almost impossible; certainly not cheap. In the second case, when applied to a proper depth, the vapor of the sulphide in approaching to within six and four inches of the surface so readily penetrates and escapes from the dry loose soil and porous ground as to become vitiated to that depth.

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[1] Two and one half quart bottles of bisulphide is equivalent to about eight pounds; this, for one hundred and fifty vines, is equivalent to twenty-five grams per vine, which is much less than the amount given in the direction herewith.

The following were the vineyardists who employed bisulphide during the Summer: Julius Dressel & Co., Sonoma; W. K. Rodgers, Sonoma; Experimental Vineyard of the Commission, Sonoma; W. Lyman, St. Helena; S. Kister, St. Helena; J. C. Weinberger, St. Helena; S. C. Hastings, St. Helena; R. B. Woodward's estate, Oak Knoll; Mrs. J. D. Blanchar, Oak Knoll; F. Salimina, Napa City; M. M. Estee, Napa City; W. B. West, Stockton.

Reports were solicited from each of the above, some of which will be given briefly. Messrs. Dressel & Co. appeared at this office and rendered the following verbal report:

> Treatment made in July; labor performed by Chinese, and superintended by competent white men. Curative treatment applied to one and one half acres of Chasselas, six feet apart by seven feet; soil so hard as to render a crowbar necessary to make the holes, thus making the work long and expensive; rules [as laid down in this work] followed. Six vines died; many suffered for a week or two, after which they showed signs of improvement. This improvement rendered those vines which had received the treatment clearly distinguishable from those which had not been treated with the sulphide. The first examination was made two weeks after treatment, at which time only surface roots were examined. On these, phylloxera were still found. Further examination, however, proved, that although found from two to six inches below the surface, deeper down all seemed dead. No increase of crop.

No fertilizers were applied with this treatment. Considering the fact that the most unfavorable season possible[1] was chosen, the results are even better than should have been expected. The months of June and July should in no case be chosen for this work, unless followed immediately by a complete watering of the surface of the ground by some insecticide, proper for the destruction of the surviving phylloxera which are to be found on the surface roots.

The results obtained at the vineyard of Mr. W. K. Rodgers are much more satisfactory than the above, which is undoubtedly due to the work having been performed before the Summer had become so advanced as to dry out the soil; furthermore, although no fertilizers were applied to Mr. Rodger's vineyard, the soil is of that rich deep nature which in a degree makes up for the fertilizers which, notwithstanding the richness of a soil, should ordinarily be applied.

Through the kindness of Mr. Rodger's step-son and foreman, we are able to present the following complete report of work effected at this place.

SONOMA, October 9, 1881.

J. H. Wheeler, Esq:

DEAR SIR: Yours with series of questions has come to hand, in answer I will say:

First—That the bisulphide was applied in our vineyard, commencing on or about the sixth day of June, and stopped on the second of July.

Second—The work was performed by Chinamen, under my own personal supervision.

Third—The difficulties met were many. The first and most important difficulty was the hardness of the soil beyond the depth of six inches. This was overcome by the use of a crowbar of octagonal steel, three fourths of an inch in diameter, and about three and one half feet long, to be driven down with six pound sledges and thus prepare the way for the injector.

A second difficulty was to make the Chinese understand the figuring of the squares for the injections; this, however, was overcome by patience, they then applying it, I think, as well as any one could.

Fourth—The directions given were followed, I may say, exactly.

Fifth—As to the effect on the vine: for a few days there was a perceptible drooping during the heat of the day, but after two or three weeks they recovered completely.

Sixth—As to the effect on the insect—I will say that I went over the vineyard two or three times in about two months, and found no insects where the carbon had been applied; but about the middle of September the treated spots were examined in company with Mr. Morse, the insects being found near the surface in places where the bisulphide had been applied. None were discovered below ten inches, but to this depth they were found. I immediately made what is called a "surface treatment" on one or two spots, and then allowed about ten days to elapse, when another examination was made, and I found not the least sign of a living insect.

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[1] See Conclusions of the Commission on Sulphide of Carbon and Sulpho-carbonates of the International Phylloxera Congress of Bordeaux.

From experience had, I believe that the bisulphide, if applied to an entire vineyard, in as short a time as possible, at the proper season, would be a success as a remedy against phylloxera. There is a larger crop on the vines that were treated than on those that were not.

My belief concerning the reappearance of the insects in the latter part of Summer is, that it is due to its invasion by aid of the winged insect from neighboring spots not treated (only a part of the infested spots having been subjected to treatment.)

Where the recent surface treatment was not made, the insects are now to be found, though in vastly diminished numbers, and appearing to me smaller than before treatment. In some places the vines were found to be throwing out new roots, small, though decided.

I intend applying the carbon again immediately after the first rains.

Yours, most respectfully,

E. P. SANDERS.

The vineyard belonging to H. Appleton, situated near Sonoma, was chosen by this Commission for experimental work of different kinds; being already badly infested with phylloxera, and occupying an extremely poor and shallow soil.

The work done with fertilizers consisted of varying kinds and combinations placed on alternate blocks of the vineyard, so disposed as to demonstrate by comparison with spots receiving no fertilizer the advantages attributable to their aid. The materials used were the following: Ashes and superphosphates; sulphate of ammonia; superphosphate; ashes; Chili saltpeter.. Previous to their application these were all rendered soluble, then applied in solution in five gallons of water per vine put in basin about the vine. The results of these fertilizers were not discernible during this, the first year; from which it is supposed that the application was made too late in the season (May and June). The crop of grapes on the whole five acres, comprising the vineyard, amounted to three tons more than was last year produced on the same piece. There being a general diminution in crop throughout the State and in Sonoma, this marked increase in this vineyard may be attributed to the combined action of the sulphide of carbon—applied throughout the whole vineyard—and the fertilizers.

The true results of this work will be seen during the ensuing year, as well as the effects of the carbon bisulphide applied. The latter was applied in curative treatment to the whole piece. The treatment occupied the month of June. Ten days subsequent to the application, examinations revealed survivors on the surface roots; at this, a surface treatment was made by injecting into each of four holes about each vine, and one immediately under the vine, ten grams of bisulphide, the injector being forced down only about four to five inches below the surface. This seemed, for the time, to effect the complete destruction of the insects, no trace being discovered in after examinations until the following September, at which time a reinvasion seemed taking place, and a few were discovered on the surface roots. The experiments on this vineyard with sulpho-carbonate of potassium, as well as with carbon bisulphide, fertilizers and other insecticides will be continued during another year, at the expiration of which time the results will become more apparent.

From the other vineyards treated, meagre and imperfect reports only were received, and from some not any. Their treatments took place too late in the season to expect complete results, and there maintained, in most of these cases, an expectation of repeating the dose at the proper season, namely, during the coming Winter.

CONCLUSION.

In closing this account of the treatments made with carbon bisulphide in California, we are brought to the conclusions that nearly all of the phylloxera, if not all, infesting a small area, may be destroyed by a Winter treatment with sulphide of carbon. That, with one exception, the remedy acts in California similarly to what it does in France, and that therefore the conclusions of the Commission on Bisulphide and Sulpho-carbonates of the Phylloxera Congress of Bordeaux (translated and given in this report) may, in general, be applied to California. We hope and believe that there exists one difference, namely, that inasmuch as the insects have a lesser capacity to spread in California, they may be entirely exterminated in those spots where it first makes its appearance, by a timely and energetic application of insecticides.

It has been amply demonstrated that it is impracticable to apply sulphide of carbon to large areas in Summer, unless the soil may be irrigated and the surface moistened.

The only operation which seems applicable in Summer, is that with sulpho-carbonate, or other liquid insecticide, in solution; or of destroying the phylloxera in centers or starting points, by first wetting the surface of the ground completely and then applying sulphide of carbon.

The sustaining of the vineyard may be greatly aided even by the application of small quantities of sulphide of carbon poured into holes near the root of each vine, as proved by last Winter's application to Mr. Reed's vineyard, in Brown's Valley.

The reinvasion of the phylloxera may be expected in all cases where the spot treated has not been properly circumscribed, *i. e.* treated far enough away from the diseased center to preclude the possibility of survivors.

Reason alone is sufficient to convince any one of the necessity of applying fertilizers to resuscitate the weak vine after destruction of the parasite.

No injury to the vine need result from the application of carbon bisulphide, if applied in curative or periodical treatment as directed in this work. In applying the death treatment, those vines only will succumb which are badly reduced in strength, and the results of treatment in rich and deep soils are more favorable than in poor soils.

THE USE OF CARBON BISULPHIDE AND SULPHO-CARBONATE OF POTASSIUM IN FRANCE.

It is here thought advisable to give some of the practical results met with up to the present in France. The reports selected are those of the Commission on carbon bisulphide, sulpho-carbonate, etc., of the International Phylloxera Congress, of Bordeaux, made in

September, 1881. This Commission was composed of Messrs. Plumeau, President; Gayon; Regis, Richier, Paul Princeteau et Falieres, Reporter. Their report is authentic and recent. In translating the following the text is strictly adhered to, the production being as near literal as is consistent with making sense in English. The cases reported comprise those examinations made and given by the committee from which they deduce the logical conclusion that, "*the European vine may be successfully maintained in spite of the attacks of the phylloxera.*" Succeeding the preface of the report appear the following:

On the twenty-fourth of August, the vineyard belonging to Mr. Paillet at Catusseau was examined. The soil was found to be a silicious clay interspersed with gravel; mean depth sixteen inches to the subsoil, which was of clay. The production of numerous healthy roots was noted even on those vines reduced the year before to the very last extremity, branches one tenth only of their natural size and length, and the green color of the foliage, showed that the application of a curative treatment during the Winter had done all that it was legitimate to demand in the first year. In the infested spots, and on twelve acres about them, the vines are equally green—have produced anew the organs of absorption, and appear in general in much better condition to receive a second treatment.

M. Durand-Desgranges, on the same soil, applied the sulphide at the rate of one hundred and fifty-eight pounds per acre in the Winter of 1880, to very sick vines, which now present a beautiful vegetation. On one portion treated there are but feeble signs of the effect, but on the remainder the improvement is so marked as to encourage the proprietor to repeat the treatment another year.

At Château-Corbeil, at Blanquefort, M. Ginouillac put in twenty grams of carbon bisulphide in four holes symmetrically disposed about each vine. A portion of these vines were strongly phylloxerated, and growing on a limey-clay soil mixed with gravel. The green aspect of the foliage and the formation of new roots, forced by a good practical manuring in November last, indicates plainly that the vineyard will, next year, return to its normal vegetation if the treatment be continued as commenced and as the proprietor has decided it shall.

At Pontet-Canet, at the first indication of the disease, Mr. Cruse applied the sulphide in connection with a fertilizer recommended by the *Association Viticole de Libourne.*[1] He took the precaution to treat well outside the infested spots. The preservation of the vineyard is extremely beautiful. Here is seen a clear proof of the great importance of commencing to operate upon the disease at its first appearance, when the root system has not yet been destroyed, and the exterior parts still show an apparent vigor.

On the part of the sulpho-carbonates, the effects are at least quite as striking. In June, 1881, a curative treatment with sixty grams of sulpho-carbonate of potassium, in seven gallons of water, were applied to each vine in the portion of the vineyard belonging to Dr. Boymiér, at Sainte-Foy, which was before very sickly and much reduced throughout. As indicated by its appearance to-day it is perfectly rejuvenated.

Madame de Errazu, at Cos d'Estournel, has obtained very encouraging results following the first treatment with the sulpho-carbonate.

At Mr. Grazilhon's Château Beau-Site, at Saint Estèphe, we have observed, on the first of September, the general maintenance of vegetation coinciding with the green color of the leaves and the sudden disappearance of the insect.

On the road from Lignan to Béziers is a vineyard belonging to Mrs. Téron which is dying on both sides, and which the owner had concluded to pull up. It has been almost completely regenerated by an application of sulpho-carbonate, assisted by an energetic chemical fertilizer. In this exists a remarkable example, not only of the efficacy of the insecticide, but also of the power of the fertilizer employed in the state of solution in water.

VINEYARDS RECEIVING TREATMENT FOR TWO YEARS.

M. Larroucaud, Mayor of Pomerol, has used the sulphide for two years; one hundred and fifty-eight pounds per acre; vines completely invaded at the time the treatment began; manure added; vegetation now perfect; nearly full crop.

In the syndicate of Fronsac numerous spots, separated from each other by considerable distances, have been treated with sulphide for two years. Throughout these vines show the good

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[1] Dry blood, containing ten per cent. nitrogen—pounds	88
Superphosphate of lime—pounds	220
Sulphate of potassium—pounds	220
Sulphate of iron—pounds	44
Sulphate of ammonia—pounds	44
Per acre—pounds	616

influence of the treatment. It has taken the first year to establish the root system of the vine. The second year had its good effect on the branches and fruit; these have become now all that they had ever been in preceding years.

Mr. Tastet, near Blanquefort, is applying sulphide of carbon for the second year (two hundred and eleven pounds per acre, distributed in sixteen thousand holes). Soil: strong, sandy clay. A striking contrast is shown with neighboring vines not treated. A gradual revival has been taking place.

The most beautiful example of restoration in two years with sulphide of carbon is that noticed at Courteillac, belonging to M. Henri du Foussat. The frost or elements have in no way interfered. A careful treatment was applied the first year, and in 1881 a complete manuring was had in Spring. The results are veritably splendid. All vines alive at the commencement are to-day in full vigor. The phylloxerated spots have completely disappeared, leaving no sign of the invasion except a few dead vines which were so before the treatment began.

It is only necessary to examine the vines treated with sulpho-carbonate of potassium to find similar successes.

At Saint-Sernin, Pontet-Canet, and Chateau-Crock in Médoc, vineyards have been regenerated with startling rapidity. Branches and foliage have been brought back almost to their normal condition. The fruiting is not so abundant throughout the Médoc, but it is only because of other causes than the phylloxera. One vineyard, belonging to Mr. Guibert, which had been attacked, was treated for two years, and gives this year two thousand six hundred and fifty gallons of wine per acre (at one hundred and thirty-five gallons per ton of grapes equals nearly twenty tons per acre).

VINEYARDS RECEIVING TREATMENT FOR THREE OR MORE YEARS.

The treatments for this period seem to crown the struggle. It shows us many hundred acres submitted for three, four, or even five years to sulpho-carbonic treatments, may be with sulphide of carbon, may be with sulpho-carbonate of potassium. Permission is requested to bring the treatments of these periods within one category, and not to distinguish between them. If, for three years, the insecticidal operations have been properly conducted; if, in connection, the necessary auxiliary fertilizing and cultivating have been done with care, and this has brought about the normal state of the vine; if a perfect root system has resulted; if fruit and luxuriant canes have reappeared over the diseased spot, it is then unnecessary to continue further the distinction between three years and longer periods.

The first examination of this class of treatment made by the committee, was at Pomerol vineyard, of Trotanoy, attacked at a number of points in 1873, completely invaded and overrun in 1876 and 1877. Six hundred and twenty-five acres were selected in 1878, and have since been defended by applications, repeated each year. The zeal displayed by this proprietor has become notorious, as, owing to climatic disasters, scarcely a crop has been produced since 1875. To understand this case, it is necessary to state that, in 1876, all vines affected with phylloxera were very badly frost bitten. The first treatment with sulphide of carbon was a somewhat confused one, made in 1876-7, when little was known of the proper procedure with this material. Thirty acres only were treated.

In 1878, for the first time, the vineyard received a complete treatment throughout. In 1879, the crop became reduced to one quarter by defective flowering. In 1880, the vegetation was returned to its proper condition. All appeared beautiful until June rains, coming after the flowering of the grape. A general dropping off of the grapes from the stems resulted; the stems followed, after a few heavy frosts, which came in August.

In 1881, after four years of successive treatment throughout, the crop and foliage were destroyed by two heavy frosts, one at the end of April, the other on the twenty-fifth of May. The vegetation had not grown so profuse as it had the year before. Considering these unfortunate circumstances caused by the elements, the impoverishment of the soil at a number of points, and the lack of invaluable fertilizers there is seen a sure demonstration of the continued efficacy of the sulphide of carbon, for the maintaining of vigorous vines and the restoration of feeble vines.

In the same commune of Pomerol, at Lafleur, in Mr. Henry Greloud's vineyard, is to be found a soil naturally rich and deep, which has been treated each year with the addition of different fertilizers. In this is offered a beautiful example of regeneration except in one spot, very gravelly, where success still awaits him. Here without frost an average crop is obtained. The vigor of the foliage of the vines, and their general healthy aspect commands the confidence of every person who has feared the disease.

The small vineyards of Messrs. Dumay and Gautier, at Villegouge, have for several years received the sulphide of carbon, aided by careful cultivation and the application of suitable fertilizers. This method has been productive of the best results that could be hoped for—an absolute reconstitution in the woody material and a full crop of grapes.

At Saint-Émilion a number of vineyards have been remade; growing in a good soil, they were taken in time with the application of a perfected treatment. In one place where the soil consists of poor disintegrated limy material the vines were dying when treated. The treatment has brought them back to a semi-vegetation without fruit. In this case the proprietor followed carefully the prescribed treatment, carrying it even to the dying vines.

From this vineyard the committee passes next to the domain of Baboulet, near Béziers, a vineyard controlled by a syndicate formed for the destruction of phylloxera. Here are two hundred and five acres of vineyard planted with *Aramon*, *Carignane*, and *Bourret*.

The soil is generally of calcareous clay, deep, loose, and fertile; visibly attacked in 1877. In the winter of 1877-8, Mr. Jaussan treated with sulphide of carbon thirty acres, at the rate of two hundred and sixty-four pounds per acre, applied in double treatment, eight days between the two applications. All of the infested spots were well circumscribed. At the end of the season new infested spots were revealed, and the following year the field of operation comprised one hundred and twelve acres. This met with encouraging results, and determined the proprietor in extending the application in 1879-80 over two hundred acres, applied at the rate of twenty grams per square yard, which same has been repeated during the present year. We are here able to state, that after three years treatment the crop has been raised to one thousand one hundred and forty-four gallons per acre (at one hundred and thirty-five gallons per ton, over eight tons per acre).

The mean crop during seven years preceding the appearance of the phylloxera, 1870 to 1876, had been a fraction over one thousand and ten gallons per acre, or something over seven tons per acre. In 1881, in spite of very considerable ravages of the pyrale, whose march was not stopped, and other unfavorable circumstances which hindered vegetation, Mr. Jaussan harvests about five tons to the acre. Throughout, the vineyards present the appearance of health, and marked evidence of the conservation of the vines by sulphide of carbon in a soil sufficiently fertile. However decisive may appear the principal results of sulphide of carbon treatment independent of the delicate conditions which may arise in some cases, a careful examination of the vines regenerated by its employment, does not prove that this regeneration may be in every case effected regardless of conditions.

The sulpho-carbonate of potassium, which has claimed the attention of viticulturists for but three or four years, has not had the wide application received by the sulphide of carbon. Experiments for this period have been only on limited surfaces, and with confused methods. The Commission have unanimously recognized the fact that, other things being equal—soil, culture, extremity of the malady, and the auxiliary assistance of fertilizers—the sulpho-carbonate is more certain to bring back the vine to its healthy condition, and that more rapidly, than the sulphide of carbon.

When we place side by side the two hundred and thirty thousand vines which have been brought forward by the *Société Nationale contre le Phylloxera* in the four domains of La Gironde, Lot-et-Garonne, and of Dordogne, from the last degree of ruin to a state of luxuriant vegetation and fruiting, normal throughout, one rests convinced, that by means of the sulpho-carbonate, the vine can be made healthy again. It is now well known that the most brilliant successes do not, as we often have occasion to repeat, address themselves to other than soils which are deep and fertile, and where care and expense are suffered.

A member of this committee who examined the vineyards of Montet, and of the Vergnes, near Sainte-Foy, three years ago, at the time when treatment was begun, states that they were then in a deplorable state. The vines were reduced to the last extremity; only alive, and supported by the main root, just at the base of the stem; also, deprived of leaves and secondary branches. Neglected cultivation prevailed because of the rapid falling off of the revenue, and in consequence the remaining parts were precipitated in the general ruin. In September, 1881, a visit paid by the committee produced astonishment and satisfaction to all; the vineyards being found in good condition, in the place of the dry, languishing, and withered stumps observed three years before by Mr. Falieres, of the commission.

It would be too long to detail the successes which have crowned the labors of the *Société des Sulfo-carbonates* in their liberal action. A resume, however, will be indulged in.

AU MOUTET. *Vineyard of White Semilion.*—Five years old; reduced to branches of four inches; completely regenerated and brought back to full bearing, according to the opinion of the most competent members of this commission.

Old Semilion Vines.—Restored alike in vegetation and production of fruit. Bordering on this vineyard is one which has received no treatment, and on which the vines have entirely perished, in spite of the most complete cultivation which they have received.

AT VERGNES. *Ferdinand Vineyard.*—Beautiful vegetation of the sick vines after three year's treatment; the effect evidently superior to that of sulphide of carbon; considerale crop.

Prunier's Vineyard.—In 1879, produced thirteen gallons of wine; in 1880, produced twenty-six gallons of wine; in 1881, produced five hundred and twenty gallons of wine.

Cabane Vineyard.—In 1879, produced twenty-six gallons of wine; in 1880, produced seventy-three gallons of wine; in 1881, produced five hundred and twenty gallons of wine.

Palliers' Vineyard.—The vegetation is ameliorated, but not having received a fertilizer with the sulpho-carbonate, the fruiting continues without perceptible increase.

Petit Vineyard.—Had been given up as lost. Crop produced in 1879, two hundred and twelve gallons; this vineyard produced this year one thousand and sixty gallons.

Pièce des Four Journaux.—The regeneration has been less than the preceding as regards vegetation, but a reconstituting has taken place in what were formerly old and decayed vines; crop, good.

MUTS BARBETEAUX. *Muts Vineyard.*—Luxuriant vegetation; small harvest, according as the setting of the fruit in Spring permitted. Here is to be seen the result of an imperfect application, which the proprietor hopes to remedy during the next year by the aid of chemical fertilizers, and a strong dose of sulpho-carbonate.

Pièce de la Fontaine.—Very beautiful regeneration, and half a crop only, on account of poor setting in Spring.

Pièce de Fayolle.—This vineyard has received three treatments with sulpho-carbonates without fertilizers; small harvest, the grapes having set poorly; vines paler green, and the appearance of much less vigor than is displayed by those vines which have received chemical fertilizers.

If we pass now to the beautiful district of the Provenquière, near Béziers, we find on two hundred and seventy-five acres, which have already received three treatments with sulpho-carbonate, positive proof of the advantage arising from applying the treatment at the very beginning of the evil. The superior intelligence of Mr. Teyssonniére has not permitted him to hesitate in treating the whole of his large vineyard when there were presented only starting points of the insects. He has been willing to act with insecticides as one acts with submersion. This resolute attitude has not prevented a general invasion by the insect any more than submersion will prevent the reappearance of the phylloxera at the end of the month of July or of August on the vineyards inundated. But under the influence of the treatment the old phylloxerated spots have disappeared. Every year reveals new spots, quite inoffensive, to be sure, of which the treatment following leaves not a trace. Throughout the vineyard, at the time of our visit, which was on the day commencing his gathering, the vineyard was in excellent condition and loaded with fruit. In a large plot at the entrance to the Château, the production exceeds two thousand one hundred and twenty gallons (nearly sixteen tons) per acre. The appearance of the disease about Provenquière is most disgusting, and it is really a marvel to see the great extent of vineyard belonging to Mr. Teyssonniére maintained, vigorous and productive, in the midst of such general disaster. The crop, which one month since was estimated by certain persons, who seem to have calculated blindly, at twenty-six thousand five hundred gallons, has reached two hundred and thirty-eight thousand five hundred gallons.

Faithful to our programme, which refers throughout to facts produced in common culture, and with the limited means which are at the disposal of the proprietors, we refer from memory only of the application of sulpho-carbonate at *l'Ecole d'Agriculture de la Gaillarde,* and at *Mas de la Sorres,* at Montpellier. Here were obtained valuable instructions; but the viticulturist is governed, not according to facts exclusively scientific, but according to experiments, practical and real. *La Gaillarde* and the *Mas de la Sorres* have been, throughout, examples of the elimination due entirely to the procedure on which the universal effort of resistance or of reconstitution should be carried on. Throughout *Mas de la Sorres* the sulpho-carbonate takes the first rank. We have not been able to explain the absolute repulse of the phylloxera except by the timely and repeated heavy doses of sulphide of carbon.

In Mr. Henri Marès' vineyard, on the plain of Launac, there remains to-day, within a space as far as the eye can reach, only from forty to fifty acres, which same this eminent agriculturist has defended regularly for three years with the sulpho-carbonate, applied with the aid of water. The old points of attack have been regenerated with difficulty; but the reconstitution is shown no less beautifully on the whole from the point of vegetation and fruit. One large piece carries a crop estimated at one thousand and sixty gallons per acre (about eight tons of grapes per acre), in spite of the non-bearing spots produced by the insect. *The sulpho-carbonate sows the grapes on the vine,* says Mr. Marès.

THE COST OF USING INSECTICIDES.

The periodical treatment is the one most used at the present day in France; during the last year nearly five thousand acres received the annual dose. The treatments of this nature occupy large territory in France, owing to the advance which the insect has already made. Over one million two hundred and fifty thousand acres have already been destroyed, and as much more is to-day infested. In the department of the Gironde, for instance, there are not less than three hundred and forty-one thousand two hundred and fifty acres infested with phylloxera, and fifty-one thousand two hundred and fifty acres killed out of a total area of four hundred and thirty thousand acres.[1] It would, in the last mentioned district be folly to attempt, with insecticides, the total extermination of phylloxera in any one vineyard surrounded so completely by the contagion. The reinvasion, reproduction, and escaping of previous treatments is therefore met by regular annual treatments, diminishing the dose for years subsequent to the first, and regenerating by the use of fertilizers. With proper treatment of this nature, some vineyards in France, which had become very badly reduced, were, in the course of three years brought to bear more than ever before,[1] owing, of course, after destruction of the parasites, to the action of the fertilizers.[2] This form of treatment appears to "pay" in vineyards where the annual crop of grapes per acre amounts to only one ton. May it not be equally afforded in this State where three tons are considered a low yield, and where even six or ten tons might be otherwise sacrificed to the inroads of the insect?

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[1] *Rapport sur Les Travaux Administratifs par M. Tisserand.*

It should be noticed particularly in this connection, that there are scarcely any vineyards requiring treatment throughout their whole extent. Now, as this treatment prevents contagion from spreading rapidly to surrounding healthy vines, it therefore acts indirectly on those not treated; and when a calculation is made on the cost per acre, the treatment should be considered divided among the whole area of the vineyard. As an instance of this, suppose a vineyard of one half infested vines receive treatment in the infested half; suppose the cost of treatment of this infested half were thirty dollars per acre; here the treatment of the vineyard is virtually at a rate of fifteen dollars per acre. If the infested spot occupy only one sixth of the whole vineyard, the treatment then virtually costs but five dollars per acre. Thus it may be seen that the smaller the spot the less the cost per acre. This reasoning further shows the practical gain in the early discovering of the attacked spot and its immediate treatment. This reasoning, so perfectly evident, is often overlooked by men who, when told that the treatment costs thirty dollars per acre, compare this with the product of the year before on the infested and thereby much reduced vines, and jump to the conclusion that the treatment cannot be profitably made. Reasoning thus hastily may lead the vinegrower to procrastinate, and thereby increase this necessary expenditure, which should in reality be divided among the total number of acres of vineyard, young and old, diseased and healthy.

INSTRUCTIONS RELATIVE TO THE DISTRIBUTION OF CARBON BISULPHIDE IN PHYLLOXERATED VINEYARDS, ARRANGED FOR DIFFERENT SYSTEMS OF VINE CULTURE.

Observation proves that the roots of the grape vine extend from one vine to another in such a manner that no portion of the vineyard can be considered free from phylloxera. It is therefore necessary, in order to effect complete disinfection, to introduce the sulphide of carbon into the soil in such a manner that the distribution of the vapors shall be as uniform as possible.

In conformance to the above it becomes necessary to divide up the surface of the ground for injections. Thus, when a specified amount of material is to be applied, it is necessary to denominate it as so much per square yard, and not so much per vine.

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[1] See experience in France with carbon bisulphide and sulpho-carbonate *ante*.

[2] See Fertilizers, recommended to follow the insecticidal treatment, published in R. of C. of P. C., at B., and given in this report.

In the following tables are to be found figures indicating, as well as can be done, the distribution of the sulphide necessary for the most common system of vine culture practiced in California.

To conform to the prescribed disposition of injector holes, it is necessary for the workmen to carefully insert the injector vertically in the soil, at the points corresponding to those designated in the following annexed plans.

It is evident that the distribution of the sulphide will be modified if the apparatus be forced obliquely into the soil, more in one direction than another.

The workmen must always force the instrument into the soil as deep as possible. It is here necessary to remark that the following tables have been calculated for those vineyards in which the vines are yet sufficiently vigorous to be able to withstand the abundant vapors of carbon bisulphide.

If the vines to be treated are already very feeble, and have remaining but few roots, or if the operation is to be performed on very young vines, it is well not to exceed in amount twenty-one grams per square yard for the single application, or twenty-five in double application.

Referring to the conclusions of the Commission of the International Phylloxera Congress, it is seen that to avoid injury to the vine in using carbon bisulphide, the working of the instrument must be guarded carefully to prevent an overdose. The employment of the sulphide in shallow soils, when excessive moisture prevails, must be avoided; lastly, the quantity must vary with the depth of the soil. The amounts given in the following tables are calculated for loose or rich soil, calcareous or gravelly, and not less than two feet deep, and for vines not already badly reduced in strength. If the soil be of compact clay, very wet or very shallow, then must the quantity per square yard be reduced. As an example of this, the application of twenty grams per square yard for a soil two feet deep, becomes, in reality, forty grams if the soil be only one foot deep. Again, a wet or compact clay soil does not allow of the loss by evaporation from the surface as does one of gravel or loose earth, and therefore the quantity which would evaporate must be deducted.

It is further seen from the above named conclusions that to insure success with carbon bisulphide, in sustaining the vines treated, and bring them back quickly to their normal condition, fertilizers must be used. Those most suitable for this purpose are given in the above named conclusions, viz: eighty-eight pounds at least of real potash per acre; forty-five pounds at least of nitrogen per acre; twenty-six pounds at least of phosphoric acid per acre.

EXPLANATION OF TERMS.

Traitement à Mort.—Death treatment, which is intended to effect the death of all the insects, regardless of the vines. To use this, double the quantity named in the following tables, if the treatment consists of a single application; and, if the treatment consists of the repeated applications, increase the total by one half.

Traitement Cultural.—May be curative or periodical. The curative treatment is meant to destroy all of the phylloxera without killing the vine, and may be by repeated applications of insecticides, or by combining different ones. For example, the deep roots are treated with bisulphide in the prescribed way; the surface roots are treated with sulpho-carbonate solution or phenyl; the vines above ground are washed with concentrated solution of sulpho-carbonate or phenyl, and a strong chemical fertilizer is applied. The periodical treatment is one repeated at stated intervals; such, for instance, is the annual treatment to kill off the insects which invade each year from surrounding premises, or which may survive the treatment of the year before.

Again, a treatment may be:

Traitement Réitéré, or Double Treatment—Consisting of a repeated application in which the total quantity per square yard is divided between two doses made six days apart in Winter, and four days apart in Summer.

Traitement Simple, or simple treatment.—Consists of a single application, in which sufficient is introduced to destroy the phylloxera in one operation.[1]

The dose proper for the periodical treatment, being applied in double treatment (according to the tables) for the first year, should, in subsequent years, be reduced from twenty-six to twenty grams per square yard; even sixteen grams per square yard may be used in the following years if the insects become so reduced as to warrant it. No reduction in the amount should be suffered if the treatment be that of a single application. To accomplish the reduction in the double treatment, one ring or measure on the plunger of the injector may be removed. The removal of one ring from the number given, reduces twenty-six to about twenty-two grams per square yard; the removal of two rings reduces the dose from twenty-six to about nineteen grams per square yard; three rings reduces from twenty-six to about sixteen grams per square yard, etc.

The following tables are calculated at the rate of twenty-six grams per square yard in the treatment consisting of two applications, and of twenty grams per square yard for treatment consisting of a single application. In the tables given, each vine is represented by a cross, and each injection hole by a small circle. The injector, as used in California, is the same as that used in France at the present time, whose unit of measure is the gram. The measure being always at hand, the denomination "gram" is no objection; if the gram were not used, the weights used by druggists, and representing an exceedingly small quantity, would have to be used—weights which are quite as little known. Let it be remembered that 28.4 grams make one ounce avoirdupois.

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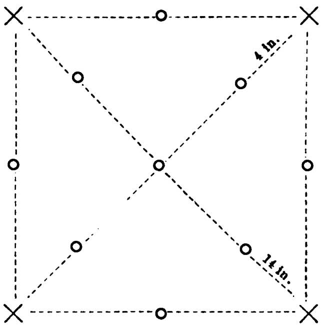
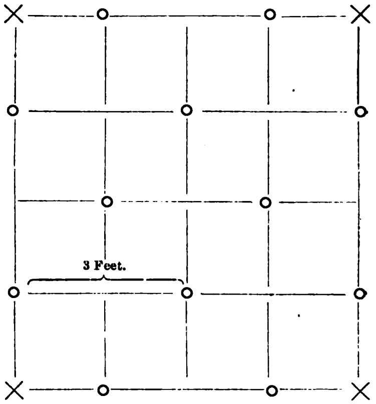
[1] For full explanation of this, see work on "Diffusion," by Prof. Marion, given in the first part of Appendix C. In this reference it may be seen that the treatment consisting of a single application is never as satisfactory in its results as that consisting of the repeated application.

Vines 6×6 Feet.

No. 1.



No. 2.



Double Treatment.

First Application.—(*Holes as in No.* 1.)

Amount per hole .... 10 grams.

For all except those on the diagonals, fourteen inches from the vines, for which apply five grams only. (For this work arrange the injector for five grams, then, to inject ten grams, make two strokes of the piston.)

Second Application.—(*Holes as in No.* 2.)

Amount per hole .... 7 grams.

Total of first and second applications, per acre .... 279 lbs.

Single Treatment.

(*Holes as in No.* 2.)

Amount per hole .... 10 grams.
Amount per acre .... 212 lbs.

Vines 6½×6½ Feet.

Use the above scheme and the following amounts:

Double Treatment.

First Application.—(*Holes as in No.* 1.)

Amount per hole .... 6 and 12 grams.

Second Application.—(*Holes as in No.* 2.)

Amount per hole .... 8 grams.

Total of first and second applications, per acre .... 272 lbs.

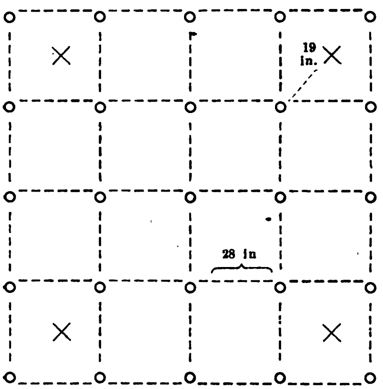
Single Treatment.

(*Holes as in No.* 2.)

Amount per hole (arrange instrument for six grams and make double stroke) .... 12 grams.
Amount per acre .... 218 lbs.

VINES 7×7 FEET.

No. 1.



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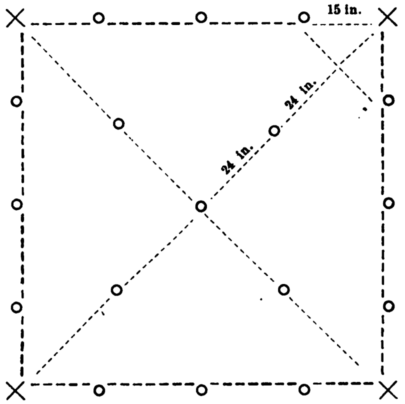


Double Treatment.

FIRST APPLICATION.—(*Holes as in No.* 1.)

Amount per hole.......................8 grams.

SECOND APPLICATION.—(*Holes as in No.* 2.)

Amount per hole....................... 6 grams.

Total of first and second applications, per acre.......................276 lbs.

Single Treatment.

(*Holes as in No.* 2.)

Amount per hole....................... 10 grams.
Amount per acre.......................215 lbs.

VINES 7½×7½ FEET.

Use the above scheme and the following amounts:

Double Treatment.

FIRST APPLICATION.—(*Holes as in No.* 1.)

Amount per hole.......................9 grams.

SECOND APPLICATION.—(*Holes as in No.* 2.)

Amount per hole....................... 8 grams.

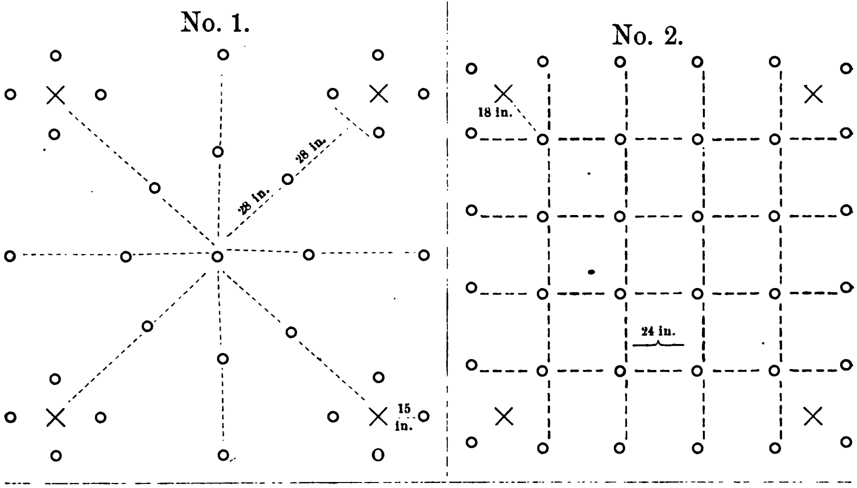
Total of first and second applications, per acre.......................286 lbs.

Single Treatment.

(*Holes as in No.* 2.)

Amount per hole....................... 12 grams.
Amount per acre.......................222 lbs.

VINES 8×8 FEET.



Double Treatment.

FIRST APPLICATION.—(*Holes as in No.* 1.)

Amount per hole	7 grams.

SECOND APPLICATION.—(*Holes as in No.* 2.)

Amount per hole	6 grams.
Total of first and second applications, per acre	279 lbs.

Single Treatment.

(*Holes as in No.* 2.)

Amount per hole	9 grams.
Amount per acre	215 lbs.

VINES 9×9 FEET.

Use the above scheme and the following amounts:

Double Treatment.

FIRST APPLICATION.—(*Holes as in No.* 1.)

Amount per hole	9 grams.

SECOND APPLICATION.—(*Holes as in No.* 2.)

Amount per hole	7 grams.
Total of first and second applications, per acre	271 lbs.

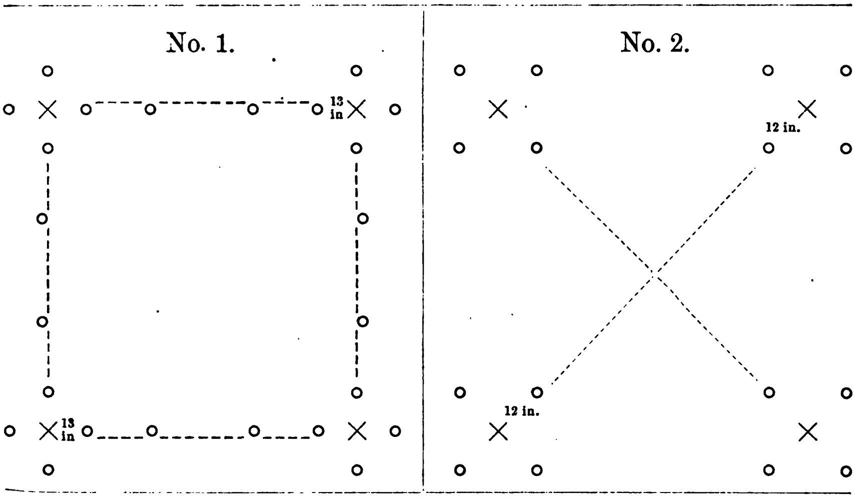
Single Treatment.

(*Holes as in No.* 2.)

Amount per hole	12 grams.
Amount per acre	227 lbs.

Young Vines (Any Distance Apart).

Comprising all vines one year old or less, which are known to be, or suspected of being, infected by phylloxera.



First Application.—(*Holes as in No.* 1.)

Amount per hole...4 grams.

Second Application.—(*Holes as in No.* 2.)

Amount per hole...4 grams.
Total of first and second applications, per vine, eight grams or nearly.....1 ounce avoirdupois.

This treatment is especially applicable to new vineyards planted where old vines have been destroyed by the phylloxera.

INJECTOR.

The injector used in California for applying carbon bisulphide is similar to that used in France, and consists of a compression pump of a particular kind.

The lower end of the injector is of conical shape to facilitate penetration of the soil, and made of steel. The upper part of the instrument is furnished with two horizontal handles with which to hold it, and assist in penetrating the soil. Beneath the handles is a zinc reservoir into which is poured the sulphide necessary to supply the pump. Immediately under this is a pedal by which to force the instrument into the ground with the foot.

The pipe being forced down to the greatest depth possible, the injection is performed by a simple movement of the hand. This is done by pressing with the palm the large button which terminates the piston at its upper end. This piston moves quickly through the dose chamber, which latter is furnished with a leather washer fitting tightly about the piston's end, and secures a uniform working. By pressing down an amount of the liquid is displaced by the piston, and is then forced out of an opening in the steel point which terminates the injector at its lower end. To reduce the quantity injected it is only necessary to reduce the distance traveled by the piston. This is done by encircling the plunger with brass rings to shorten the stroke. The height of these movable brass rings is calculated each to represent one gram of sulphide of carbon. Without any of the rings the instrument ejects ten grams per stroke. One ring added diminishes the stroke by one gram, making it eject nine grams per stroke; two, three, four, or five rings makes it eject eight, seven, six, or five grams instead of ten.

These rings can be arranged by the operator to suit the quantity per hole, required in the tables. As to the use of the instrument; it is found perfectly simple.

The injector is forced into the soil by pressing simultaneously on the handles and the pedal until it strikes the subsoil. With the right hand the button terminating the piston is struck, quickly and forcibly; the instrument is then withdrawn and the hole closed as completely as possibly, by stamping the earth into it with the foot. Insert the injector; strike the plunger, withdraw and close the hole—these are all of the movements.

In order to completely understand the preceding description it may be necessary to know some of the details of the construction. A large brass spring encircles the piston whose function is to return the plunger to its initiative position; by means of this, the instrument prepares itself for another dose, saving the operator the movement necessary to draw the piston back. The sulphide enters the body of the pump by several small orifices which are alternatively covered and uncovered in the passing of the plunger. Within the steel point of the instrument is found a species of clack-valve, opened only by compression of the liquid which is otherwise supported by a steel spring holding up the valve. This essential part may be readily examined at any time by unscrewing the steel point; previous to doing which, the plunger should be forced down and maintained in this position by a pin which accompanies the instrument. In this position the plunger prevents the outflow of the liquid through the valve, released by unscrewing the point. This forcing down of the plunger acts as a faucet.

The upper part of the injector which carries the handles is so arranged that the piston may be readily withdrawn for greasing and cleaning. This should be done carefully at the close of each day's work. The cleaning ought to be done with a dry soft cloth, and with proper oil, or preferably with glycerine; emery paper should never be used, nor should it be approached with sand paper, glass, sand, or any other gritty substance. It is necessary to keep the orifice leading to the reservoir corked; otherwise the sulphide vapor escapes and gravel or sand may get in.

The injector is well constructed, and will, if instructions be followed, last a long time. But it becomes immediately apparent that, if great resistance is met with in penetrating the soil, or if the instrument be used as a lever, acting latterally on the handles, the pipe or tube will become disjointed, and the soldered joints of the reservoir broken.

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to rest on the piston; in this position the bolts can easily be worked without bending) and pare down about the hole the large washer—do not cut the hole larger.

If the injector leaks at the point—that is, if the bisulphide runs continuously from the small hole in the point, it is because the valve is not in proper order. Either the spring is not sufficiently strong to support the column of sulphide and should be replaced by a stronger one, or else there is some dirt on the valve, which prevents its closing tight. If the leak occur around the joint of the pipe and point, proceeding directly from the pipe, then must the nipple which joins them be unriveted, withdrawn, cleaned, and soldered in hot. This latter work will require a tinsmith, or gunsmith.

The bisulphide is transported in California in fifty-pound tin cans, and in one thousand-pound iron barrels. These vessels should be kept in a cool place, and when in the field, should be covered with sacks, which should be kept wet if it be Summer, or exceedingly warm in Winter. When taken to the field, if a barrel, it should be placed on some elevated platform, from which the liquid can be drawn directly into the injector with a siphon. (A small rubber hose or pipe may be used for the siphon.)

If in a barrel, the bisulphide should be always keep covered with a few inches of water (which will not mix with carbon bisulphide) to prevent evaporation; and, after filling the injector each time, the stopper should be screwed in. When the sulphide is exhausted the barrel should be filled with water and emptied; then set it in the shade for about five days' airing, after which it may be shipped or transported without danger.

If the double treatment be applied, the second application should follow the first after six days if in Winter, and after four days if in Summer, each treatment being distributed in accordance with the chart, as prepared and named in this work for that treatment.

Never allow a treatment to follow cultivation within less than fifteen days; a longer time than this is better. Furthermore, never allow the treated spot to be cultivated within less than fifteen days after the finishing the operation.

The treatment with bisulphide must invariably be accompanied by fertilizing, the best combination being given on previous pages of this work.

Naturally insoluble salts should be applied early in the Winter, such for instance are bone meal, suint, farm manure, or ammoniacal manures of any kind. The soluble superphosphate, rendered so by the treatment of bone meal, with strong sulphuric acid, should also be applied early in the Winter, as its distribution through the soil is accomplished by a process of leaching by rains, the salt returning to its insoluble condition after from eight to fifteen days. The only object in rendering bone meal soluble is to distribute it in a finely divided condition throughout the soil.

Easily soluble salts, like potash salts, should be applied during January. In no case should the ammonia or potash be mixed or even applied at the same time with the artificially prepared soluble phosphate, as the mixing would render the superphosphate insoluble again.

SULPHO-CARBONATE OF POTASSIUM.

Over two thousand five hundred acres of phylloxerated vineyards in France have been treated with the sulpho-carbonate of potassium, the results of which, as may be seen in the conclusions of the Commission to the International Congress, which met at Bordeaux in October, 1881, and published in the report of the Phylloxera Committee of this Board, have been highly satisfactory. In efficacy it has proved superior to the sulphide of carbon. It seems to possess the power of returning the plant quickly to its normal condition, because of the quantity of potash contained. The expense of using the sulpho-carbonate, which must be applied in solution, appears not to permit its being used quite as generally as the sulphide of carbon.

The sulpho-carbonate of potassium is little more than sulphide of carbon rendered soluble. By placing it in this state, the poisonous vapors, being eliminated only by the decomposition of the salt, escape much more slowly, and are, by the sulphide of potassium, increased in quantity. From this it is immediately seen that the chief difficulty encountered with carbon-bisulphide in Summer treatment, namely, the porous character of the surface soil, which allows the easy escape of all that vapor within six inches from the surface, is here overcome.

The solution is spread over the ground and washed in by rains or artificial watering. A weak solution of this salt reaching the roots, destroys quickly all insect life, and, instead of injuring the plant, all that part of the material not passing into the vapor which performs the destruction of the insects, is assimilated by the plant root, and stimulates its growth as a chemical fertilizer.

The symbol for sulpho-carbonate of potassium is K_2CS_3, and is formed by combining the sulphide of potassium and the sulphide of carbon; reaction:

$$K_2S+CS_2=K_2CS_3.$$

Its preparation is attended with considerable difficulty, arising from the trouble in obtaining the sulphide of potassium. The salt formed consists of a deep red solution, which may be diluted to any extent, and will stand considerable water without losing its dense, beautiful color. As a ready soluble salt, it is susceptible of weakening. It should, as a commercial product, represent 37° Bamné, and it is this strength of solution which is taken as the standard in calculating on its application. When sulpho-carbonate is mentioned hereafter, the solution 37° Bamné is meant.

Sulpho-carbonate is decomposed by weak acids giving off sulphuretted hydrogen gas and carbon bisulphide gas; reaction:

$$K_2CS_3+H_2O+CO_2=K_2CO_3+H_2S+CS_2.$$

The respiration of the insect exhaling carbonic acid gas produces thus its own destruction. If the sulpho-carbonate be boiled, it decomposes according to the following reaction:

$$K_2CS_3+3H_2O=3H_2S+K_2CO_3.$$

A similar decomposition takes place slowly in the aqueous solution at ordinary temperatures.

EFFECT OF SULPHO-CARBONATE ON THE PHYLLOXERA.

The following determinations were made in 1874 by M. P. Mouillefert, under direction of the President of the Academic Commission of France:

To obtain these results, badly phylloxerated roots were immersed in solutions of different strength.

First—In a solution of $\frac{1}{200}$ of sulpho-carbonate of potassium the phylloxera were found dead in a quarter of an hour immersion.

Second—In a solution of $\frac{1}{500}$ after one hour.

Third—In a solution of $\frac{1}{1000}$ after one and one fourth of an hour.

Fourth—In a solution of $\frac{1}{5000}$ after two hours.

Fifth—In a solution of $\frac{1}{10000}$, after two hours immersion, out of six insects examined with a microscope one only was found exhibiting any signs of life, all of the others being dead.

Sixth—In a second experiment with a solution of $\frac{1}{10000}$ no living phylloxera could be found after two and a quarter hours immersion.

Seventh—In a solution of $\frac{1}{25000}$ all of the phylloxera were dead after twenty-four hours immersion.

Eighth—In a solution of $\frac{1}{50000}$ the same result was obtained in the same length of time.

Ninth—Finally, in a solution of $\frac{1}{100000}$ all of the phylloxera were dead after twenty-four hours immersion.

Tenth—In a vessel containing only water the insects were alive after twenty-four hours immersion.

According to M. Dumas, this sulpho-carbonate solution contains about one half its weight of dry salt. We have, therefore, in the last experiment, the insect destroyed by a solution at the rate of $\frac{1}{200000}$. A solution of $\frac{1}{1000}$ killed the phylloxera by its odor alone in less than twenty-four hours.

The sulpho-carbonate acts, then, on the phylloxera both by its vapor and by contact. Even concentrated solutions of commercial soda and potash are without effect on the insect when applied in the field, from which we know that it is the sulpho-carbonate which acts in destroying the insects, and not the alkalies.

In experiments made by the Secretary of the Board of State Viticultural Commission of California, the following results were obtained:

Sulpho-carbonate solution $\frac{1}{128}$ destroyed the phylloxera in twenty minutes immersion.

The same solution destroyed all the phylloxera in ten minutes immersion.

The last was repeated with the same results.

Experiments with the ordinary potash, or carbonate of potassium, confirm the statement of Mr. Mouillifert. One pound per gallon (making a very strong solution) failed to kill the insects after ten minutes immersion, thus proving that the sulpho-carbonate is the agent which destroys the phylloxera, and not the potash formed by the passing off of the vapor.

In the soil the effect of the sulpho-carbonate is rapidly reduced, the strength of the solution diminishing as the vapor is given off Its effect in the soil terminates after a few days, but always lasting long enough to destroy the insects and their eggs wherever the extended solution of $\frac{1}{10000}$ passes.

The sulpho-carbonate of potassium may be applied sufficiently strong to kill the vine; still, although the proper dose varies according to the time of year, no injury is produced with less than ten times the amount necessary in Winter, and five times the amount necessary in Summer.

As the results of the treatment of seven vineyards under the direction of M. Mouillefert, Professor of the Agricultural College of Srignon, are similar to those expressed in the conclusions of the Congress. Commission at Bordeaux, they need not be repeated here.

In concluding his work M. Mouillefert remarks relative to the washing of the vine above ground:

The application of a wash to the vine above ground, proposed by Mr. Balbiani to destroy the Winter egg, which latter is destined to regenerate the species, should not be neglected in the treatment of phylloxerated vineyards. Properly applied, the wash will serve to prevent the introduction of the disease from surrounding properties, and thus act as a prevention against the evil. Judging from the successes encountered at Cognac and Villegonge, the washing should enter as an important factor in the treatment of vines already infested, and will serve to reduce considerable the innumerable Summer generations which are so dangerous. This washing of the vine reduces the cost and number of necessary underground treatments.

Up to the present, the substances which have produced the best results as a wash are heavy oil (a product of coal oil refining) mixtures, or a dilute mixture of coal tar—distillate, and soda (corresponding to Little's soluble phenyl), or sulpho-carbonate of potassium mixed with its own volume or more of water.

APPLICATION OF SULPHO-CARBONATE OF POTASSIUM.

A number of methods have been proposed for applying sulpho-carbonate of potassium to vineyards, the principal ones being:

First—By placing it in holes made by an iron or steel bar.

Second—By injecting it in a manner similar to that of applying carbon-bisulphide, with an instrument.

Third—By distributing it by means of a drill or plow made for this purpose.

Fourth—By mixing it with some material to render it solid.

Fifth—By diluting with water; the latter serving as a carrier.

The first method can be used to advantage only in soils easily penetrable by the liquid and instrument. In effect, in soils of clay, the bar so presses the earth, already impenetrable, preventing the diffusion of the toxical vapor, and thereby restraining its action. In soils gravelly or rocky, the action of the sulpho-carbonate is unsatisfactory, and the operation impossible. Finally, the labor becomes a considerable obstacle, inasmuch as the application of three hundred and fifty pounds per acre necessitates the making of from eighteen thousand to twenty thousand holes.

The second method presents also the above objection.

The third method does not accomplish the uniform distribution of the material throughout the soil.

The fourth, which consists virtually in transforming the liquid into a powder in order to enable it to be sown as a fertilizer at the time of plowing or cultivating, the same to be distributed by rains in Winter, or slowly by diffusion if in Summer, has not given good results. Many substances have been used, but none has yet been obtained which will prevent the rapid decomposition of the sulpho-carbonate when placed in the soil. Again, if the rain does not follow immediately, or if the quantity of rain which falls be feeble, the solution will not descend to a sufficient depth to destroy the phylloxera.

The fifth process for employing sulpho-carbonate, which consists of mixing with a quantity of water to form a toxical solution which may be poured at the foot of the vine, in basins made therefor, of size varying to suit the system of planting, declivity of slope, etc., is the best. Let the soil be gravelly, porous, or clayey; if the quantity of water with which the sulpho-carbonate is diluted is sufficient, the diffusion of the reagent will be perfect. This is the method generally chosen, and is one which has always given certain results in rejuvenating the plant and destroying the parasites. In spite of its inconvenience it is the method recommended as most preferable.

PREPARATION OF THE SOIL.

The preparation consists, as has already been indicated, in the making of receivers, or little basins at the foot of the vine, and in such a manner that all of the space infested by the phylloxera may be uniformly penetrated by the toxical solution. This work is extremely important, and upon its proper execution depends the success of the treatment.

These basins should be made square or rectangular, and as regular as possible. The dimensions of these basins must vary with the modes of planting, and the slope of the land. Thus, in some cases, one will be made for each vine. Again, where the vines are close together in rows a number of vines may be included in a single basin. On sloping land they must be small, narrow in the direction of the slope, and long across the slope. In some countries the method of planting and cultivation assists largely in the making of the receivers, especially when cultivated in ridges.

The preparation of the basins may precede by several days the treatment, but the nearer they are together the better it will be, as when first made the soil takes up the toxical solution more quickly. Under ordinary circumstances it takes one day of ten hours, for one workman, to prepare one acre of ground in the manner required. This expense is the maximum, and applies only where the system of planting, cultivation, etc., does not in any manner assist. It is proposed to do this by mechanical contrivances, and could, in California, be largely assisted by the plow.

When the ground has been prepared as above, there is put into each receiver a quantity estimated at from thirty to forty grams (one to one and one third ounces avoirdupois) of sulpho-carbonate per square yard (according to the soil), mixed with the necessary quantity of water to completely soak the volume of soil infested. This quantity varies according to the looseness and moisture of the soil, from one and one half to three gallons per square yard.

COST OF USING SULPHO-CARBONATE OF POTASSIUM.

This will of course vary largely with the method of obtaining the water, in the conducting and distributing of which is found the most important factor. Here again it may be said that the cost per acre of treating a partially diseased vineyard must be divided among the total number of acres; that is, if one hundred acres be infested in one spot, the complete treatment of which would require the application being made to one acre, then the saving the whole vineyard, or protecting it by treatment of one acre (for the disease must if untreated continue to spread), may be properly divided among the hundred acres.

WASHING THE VINES WITH SULPHO-CARBONATE OF POTASSIUM.

Vines are washed with sulpho-carbonate in order to prevent a reinvasion, proceeding from the Winter egg (deposited under the bark of the old wood above ground, to hatch out and proceed again to the roots in the following Spring), in the spots treated; or, this treatment may be applied to healthy vines, situated near diseased spots, to destroy whatever disease may have crept in: in other words, it is a means of avoiding the evil and rendering the vineyard secure against invasion by the aid of the winged phylloxera. To do this the sulpho-carbonate should be diluted with about two parts of water and applied with a swab, brush, or spraying apparatus, any time between October and the latter part of March, being careful, however, that the application is not followed within five days by a heavy rain. On this latter account, the time most preferable is in Spring. The decomposition of the sulpho-carbonate being effected, a potash residuum results, which is afterwards washed down on to the roots and serves as a fertilizer.

Up to the present there have been no applications made in California to phylloxerated vineyards with sulpho-carbonate, because it has heretofore been unobtainable. It is now being furnished by the Secretary of this Commission, who is making the same in connection with carbon bisulphide.

APPENDIX D.

SECOND ANNUAL REPORT

OF THE

COMMITTEE ON PHYLLOXERA, VINE PESTS,

AND

DISEASES OF THE VINE.

SECOND ANNUAL REPORT

OF THE

COMMITTEE ON PHYLLOXERA, VINE PESTS,

AND

DISEASES OF THE VINE.

OFFICE OF BOARD OF STATE VITICULTURAL COMMISSIONERS,
SAN FRANCISCO, November 10, 1881.

To the Board of State Viticultural Commissioners:

GENTLEMEN: Your Committee on the Phylloxera, Vine Pests, and Diseases of the Vine, do respectfully submit the following, their second annual report, for your consideration:

Concerning details of methods of treatment of diseased vines, either with insecticides, or by submersion, or by reconstitution by grafting on resistant stocks, or the use of resistant stocks as direct producers, or plantations in sand, we shall refer you to the extended report of our Chief Executive Officer, now in course of preparation. His report, besides touching upon investigations, experiments, and experience in this State, will contain an elaborate report by the Secretary of the Commission on the Sulphide of Carbon and Sulpho-Carbonates, with directions for their use; a full translation of the *Manuel Pratique pour la Reconstitution des Vignobles-Méridionaux, Vignes Américaines, Submersion, Plantations dans les sables*, by Prof. G. Foëx, of the National School of Agriculture at Montpellier, France; also of the "Studies on Several Species of Wild Vines in North America," by M. A. Millardet, Professor in the Faculty of Sciences in Bordeaux; and other material of equal practical importance. This report will soon be published, and we therefore need not enter into such details.

Our investigations this year have demonstrated the presence of phylloxera in several counties where it was not discovered last year; the questions of combatting the pest being thereby made more complicated.

Our researches, aided by the most competent entomological authorities, tend to show that the extension of the phylloxera pest is due principally to the winged female and the consequent Winter egg, which is lodged upon the old wood of the vine, if above ground. There are no well authenticated proofs that this Winter egg is ever to be found on the new wood of the growth of the preceding year.

The habits of the insect in thus depositing the Winter egg are briefly and succinctly explained in the Chief Executive Officer's report.

It is apparent that the winged female does not exist in great numbers in our State, or at least that it does not ascend above the surface of the soil in great numbers, hence the slow progress of the disease with us. Our experiments in attempting to entrap them have been futile, and we are safe in asserting this proposition; moreover, our vineyards, with comparatively few exceptions, are more or less isolated and thereby protected from invasion.

We have therefore considered that isolation, comparatively, of vineyards, and the removal of all old wood from cuttings, together with complete disinfection of rooted vines and such precautionary disinfection of cuttings as we suggest, are the best methods we can practically recommend for the prevention of the spread of the disease from infected places to healthy vineyards within our State. This, while not affording absolute protection, because the contagion may possibly be carried in other ways—on the clothes of workmen, by insects and birds, etc.—will at least diminish the danger to its minimum.

In Eastern States, whence are being imported cuttings and rooted vines of resistant stocks, the danger of infection is probably greater. Until we can prove the contrary, we shall admit, as is claimed (with some opposition) by the entomologists, that the gall louse inhabiting the leaves of American vines is identical with the phylloxera vastatrix, or root inhabiting type. It is believed generally that the pest was introduced into Europe upon American vines; if this be true, we are in constant danger of new invasions from the same source in acclimating and experimenting with American resistant stocks from Missouri, Texas, Ohio, and New York. The danger of introducing the Winter egg upon cuttings is apparently greater with these stocks than with our own, on which the winged form appears to be less frequent; we have therefore thought it wise to caution planters to disinfect such imported cuttings carefully. This same is true of imported cuttings from Europe, where the winged form is evidently more numerous than here.

A perfect system of quarantine is impracticable at this late season, on account of the great territory of the State and the necessity of appointing careful inspectors to certify to disinfection in every place whence cuttings are sent to other parts. We do not believe that it is sufficient to designate only the vineyards where the pest has been discovered as dangerous, because it is probable that it exists in other places not yet discovered. Therefore we counsel all planters to consider all vineyards suspected, and to disinfect everything, cuttings or roots, that they procure to plant. This possibly extraordinary precaution may be further justified by the almost universal presence of some form of fungoid disease in vineyards, the germs of which, on cuttings and rooted plants, may be destroyed by the methods precautionary against insect pests.

Therefore, we recommend as the most practical means of preventing unnecessary spread of the phylloxera and fungoid diseases for this coming season of planting, the adoption and declaration of quarantine rules, as follows:

First—That the cuttings of grapevines made in this State for plantations outside of the vineyards where made, shall be required to be made solely from the new wood of the preceding season's growth; all old wood to be removed in order to prevent spreading contagion by means of the Winter egg of the phylloxera, which, according to the best entomologists, is only found on the old wood, the new wood being free from them.

Second—That all cuttings and rooted vines imported from any region or country outside the State, shall be required to be disinfected at the place of first consignment within the State before distributed or planted; the method of disinfection to be at the option of those to whom such cuttings and roots are consigned, provided that it be some one of the methods which have been experimented with and proved efficacious by the Chief Executive Officer of the Commission, full details of which will be made public.

Third—That all persons planting new vineyards within the State shall be advised and strongly urged to consider all roots and cuttings suspected, regardless of origin, and to thoroughly disinfect them, thereby accomplishing the destruction of all possible germs of insect pests upon them, as well as also those of fungoid disease, which are becoming dangerous in all parts of the country.

Fourth—That for the convenience and protection of all interested parties throughout the State, the Chief Executive Officer shall be requested to appoint resident inspectors, as provided for by law, for each section or region where vine-growers desire the same, and upon their application to him for such appointments; applications to be made by practical vine-growers, and those intending immediately to plant new vineyards, directly to the Chief Executive Officer, Charles A. Wetmore, No. 111 Leidesdorff street, San Francisco, and also that he shall appoint such inspectors at other points where their services seem positively to be required.

Fifth—That blank forms for certificates of disinfection shall be furnished to inspectors, and that the fees to be charged by inspectors for such certificates, made out in duplicate, shall not exceed fifty cents in each case, the fees and penalties in case of evasion of rules and seizures, to be the amounts prescribed by law.

The methods of disinfection, which the experience of this committee, through the experimental work of the Chief Executive Officer, aided by the constant labors of our Secretary, causes us to recommend for general use and for application, any one of the same, in cases where disinfection is absolutely required by the rules, are as follows:

For cuttings and rooted vines:

First—Dissolve sulpho-carbonate of potassium in cold water; proportions: ten pounds of sulpho-carbonate to one hundred gallons of water; immerse cuttings and rooted vines fifteen minutes.

Second—Dissolve Little's Soluble Phenyl by pouring upon it cold water in the proportions of fifty gallons of water to one gallon of the phenyl; immerse cuttings and rooted vines ten minutes.

Third—Take two parts heavy oil of coal tar; two parts water and one part carbonate of potash, or carbonate of soda; put in covered vessel and heat gently to boiling point for one hour; replace water lost by evaporation; pour into suitable vessels and agitate violently; dilute with fifty parts of cold water; immerse cuttings and rooted vines ten minutes.

Fourth—Dissolve carbolic acid crystals in water, in proportion of one pound of acid to twenty gallons of water; immerse cuttings and rooted vines ten minutes.

Fifth—Dissolve sulphide of potash in the proportion of one pound to twenty gallons of water; immerse cuttings and rooted vines twenty minutes.

Sixth—Dilute one part of "liver of lime" in twenty parts of water; immerse cuttings and rooted vines ten minutes.[1]

The foregoing disinfectants are believed to be quite efficient for the purpose and safe in practice. The solutions of sulphate of copper (blue vitriol) and sulphate of iron (green vitriol) may be advantageously used upon cuttings for disinfection against fungoid germs, but our experience indicates that the time of immersion required to destroy the phylloxera is too long to be practically followed. When used, we recommend the sulphate of iron in preference to the sulphate of copper, the former being a good fertilizer or stimulant for the vine. Rooted vines should not be washed or soaked in solution of sulphate of copper or iron. The roots are destroyed easily by this remedy.

Other disinfectants might also be used, but we recommend only those which our experience proves valuable, and which may easily be obtained by those requiring them.

SULPHIDE OF CARBON AND SULPHO-CARBONATE OF POTASSIUM.

We recognize still, as heretofore, the importance of these insecticides as aids in combatting the progress of the phylloxera, and for the especial protection of vineyards planted with the *Vitis Vinifera* varieties. Instructions as to their use and information concerning the experience had with them in this State and elsewhere, will be contained in the forthcoming report of the Chief Executive Officer. Inasmuch as the use of these insecticides in the soil may not be sufficient in exterminating all the germs of the pests, on account of the presence of the winged female and Winter egg above ground, we counsel the careful destruction of all debris of vines, cuttings, leaves, etc., after pruning, and the washing of the vines in Winter with a concentrated disinfectant, such as any one of those heretofore prescribed for the disinfection of cuttings, and more especially the treatment of the surface soil around the base of the vines with the sulpho-carbonate of potassium, or Little's Soluble Phenyl, at the time of treating the deeper soils, and also during the month of May, the time when the products of the Winter eggs seek the roots of the vine. This is especially important, inasmuch as the vapors of the sulphide of carbon appear sometimes to be ineffectual in reaching surface roots in Summer, and also possibly in Winter treatments, according to the nature of the soil.

In all cases where only a small part of a vineyard is found infected, we counsel the energetic application of the death treatment of the bisulphide of carbon, aided by surface applications of sulpho-carbonates, or phenyl, and carefully washing with very concentrated insecticides upon the wood above ground. Whenever vines so treated are killed, it would be advisable to replant with resistant stocks.

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[1] To make "liver of lime," take one pound quick lime, one pound sulphur, one gallon water; mix; boil over quick fire to one half of volume; agitate before using; dilute with twenty parts of water to one part of "liver of lime."

In cases where the disease is generally spread throughout a vineyard and the vines are still productive, we counsel the use of the curative, or periodical treatment, aided by energetic fertilizers, such as will be explained in the forthcoming reports, until such time as the treatment shows signs of failure, or the expense makes it unprofitable, in which case, the vines should be replanted with resistant stocks.

SUBMERSION.

This remedy, according to French experience, is effectual in protecting vineyards from the phylloxera; but it is in most cases impracticable, and when practicable, it must be repeated annually. Irrigation should not be confounded with submersion.

PLANTATIONS IN SAND.

It has been found that in extremely sandy soil the vine appears to be free from disastrous effects of the phylloxera. Such soils are, however, not to be found in our vine-growing regions. Sand dunes, with a small percentage of matter other than silica, appear to be the only places where this remedy applies.

AMERICAN VINES.

The resistance of American vines, or of most of their varieties thus far tested, appears to be incontestably proved. This resistance is, however, often one of degree only, and there still remains much to be learned. Practically speaking, however, there are many known varieties of several species which are phylloxera proof. In this State not much is yet known as to the adaptability of the various species and varieties to different climates and soils; and it yet remains to be proved beyond question whether the *vitis Californica* and *vitis Arizonica* are to be classed among the resistant vines. Enough, however, has been learned to render it extremely probable that these species will yet be ranked among the most valuable resistant grafting stocks. Planted side by side with the *Riparia*, they show greater vigor of growth and greater adaptability to our climate and soils.

It is important that all planters should cultivate at least a few specimens of each of the more prominent species or varieties, to test their vigor and adaptability, and as a means of obtaining cheaply hereafter grafting stocks for replanting.

Whenever it becomes necessary to plant resistant stocks at once, present experience indicates that for grafting stocks the wild *Riparia* should be preferred, and for direct production the *Lenoir* or *Jacquez*, and the *Herbemont*. The latter two are of the *Æstivalis* species, and planters should know that they are very difficult to propagate from cuttings. It is impracticable to plant them directly in the vineyard; they must first be rooted in nursery—in a warm soil, well irrigated. Rooted layers from old vines will be the surest means of reproduction. The *Riparias* root easily from cuttings.

The *Rupestris* are also to be recommended as a grafting stock for very dry lands; they root from cuttings very well, but not as easily as the *Riparias.*

In propagating seedlings for grafting stocks, only pure wild varieties should be used. Most of the cultivated varieties germinate with difficulty and show evidences of hybridization.

THE CONCLUSIONS OF FRENCH COMMISSIONS.

In connection with the foregoing opinions, we submit the following conclusions, extracted and translated from reports of special commissions made to the recent International Phylloxera Congress, held in October last at Bordeaux.

[Translated.]

BISULPHIDE OF CARBON AND SULPHO-CARBONATES.

From the experiences and facts reported above, we deduce the following conclusions and considerations:

First—The European vine may be efficaciously defended from the attacks of phylloxera by means of insecticidal applications of bisulphide of carbon and sulpho-carbonate of potassium. By the defense of the European vine, we mean a return of the normal production in weakened vines, as well as the maintenance of this same production in vines that are still vigorous.

Second—Soils that are sufficiently fertile and deep are the best adapted of all to the reconstitution of attacked vineyards and the preservation of vigorous ones. Poor soils, calcareous and superficial, do not meet the exigencies of the phylloxerated vineyard, even with the aid of fertilizers and insecticides. For the present, the agricultural operation of the establishment or defense of vineyards must not be attempted there. Rapidity of regeneration and facility of defense are in accordance with the degree of richness and depth of the soil, or with the proportion of silica which enters in its composition.

Third—Regular assistance, in the shape of fertilizers is an indispensable complement of insecticide treatment, even in soils that are fertile in themselves. Chemical composts that are quickly soluble build up weak vineyards more rapidly than farmyard manure. The dose of fertilizing matter that appears to give the best success is, per acre, about eighty-eight pounds, at the least, of pure potash; about forty-five pounds of nitrogen; about twenty-six pounds of phosphoric acid. The superiority of chemical fertilizers is evident, especially when the quantity that will affect each vine severally may be dissolved in about six or eight parts of water.

Fourth—The non-association of fertilizers with the insecticidal applications, at least in the first year over the whole surface of the phylloxerated vineyard, and in the second and third years in the parts that are still weak, results in a lack of sufficient vegetation and of a return to the former production.

Fifth—Cultivation should be more frequent than formerly, at least during the period of regeneration, which lasts, on an average, three years in vineyards that are badly attacked.

Sixth—Other things being equal, the nature of the soil and cultivation, the young vines and those of medium age regenerate more rapidly and completely than the old stocks under the combined influence of insecticides and fertilizers. It is impossible to establish with precision, the differences in resistance that may be found peculiar to divers varieties of European vines.

Seventh—In order that vegetation may not be endangered, bisulphide of carbon and sulpho-carbonate of potassium should be used only in cultural doses, that is to say, about one hundred and thirty or two hundred and twenty pounds at the most per acre for the first, and about five hundred and thirty pounds at the most for the second. In a general invasion of the French vineyard, the death treatments, used for the preservation of a district or an estate, are nearly always fatal to the plant, and do not prevent the propagation of the insect.

Eighth—In the periodical treatment, the bisulphide of carbon and sulpho-carbonate of potassium always spare a certain number of insects, which multiply to a great extent in the months of July, August, or September, according to the degree of perfection of the treatment and the vigor of the vines.

Ninth—The insecticidal treatment must be repeated every year, for fear of losing through suspension the benefit of former treatments.

Tenth—Periodical treatments at the end of the season, at the said time of re-invasion, either with bisulphide of carbon or sulpho-carbonate of potassium, give only medium insecticidal results, not in accordance with the expense and general difficulties of execution. The best time for application is from the beginning of November until the end of March.

Eleventh—Mixed periodical treatments, with half the dose of sulpho-carbonate and water put in little holes, and the other half, consisting of bisulphide of carbon, applied to the other parts of the soil far from the crown of the roots of the vines, appear to give very good results, when all other conditions—soil, fertilizers, cultivation, and age of the vine—are in accordance. They should be tried more extensively.

Twelfth—Even in the periodical treatment, bisulphide of carbon, as it is now used—that is, injected in a liquid state—sometimes determines accidents in the vegetation. These accidents appear to result from:

A. Irregular action of the distributing instruments, giving too large doses.

B. Using bisulphide of carbon during a period of great humidity in wet soil having an impermeable subsoil.

C. Excessive absorption of rain water by very clayey soil, during the period of the application or immediately after, which produces the same effects as in the case of impermeability of the subsoil.

Thirteenth—In light, permeable soil, with gravelly or calcareous subsoil, which is easily drained, the bisulphide of carbon has no bad effects, even in the rainy season, excepting on extremely weak vines, which generally succumb in any season and in every nature of soil and treatment.

Fourteenth—In the periodical treatment sulpho-carbonate of potash, whatever may be the soil and subsoil, does not cause any disastrous accidents, excepting on extremely weak vines, which doubtless would die in a short time by themselves. However, the applications used in the treatment called regenerating, given in doses of about four ounces per vine, although belonging to the cultural treatment, should apparently be avoided in May or June, according to the more or less advanced state of the vegetation.

Fifteenth—In virtue of its own composition, as well as the necessity of using quantities of water which dissolve the fertilizers auxiliary to the treatment in the most rapidly assimilable form, the sulpho-carbonate of potassium, in the majority of cases, restores the vines more rapidly and completely than the bisulphide of carbon.

Sixteenth—This superiority, a double one respecting harmlessness and a greater regularity in the return to fructification, must cause sulpho-carbonate to be preferred wherever it can be used.

Seventeenth—The annual expense of the periodical insecticidal treatment with bisulphide of carbon at present is, on an average and in round numbers, about twelve dollars per acre.

Eighteenth—The annual expense of the insecticidal treatment with sulpho-carbonate of potassium, by means of Messrs. Humbert and Mouillefert's mechanical apparatus, is from about twenty-eight to forty-eight dollars, according to circumstances. We may take the figures forty dollars per acre as a base of calculation for the first year, and thirty-two dollars per acre for the following years.

Nineteenth—The expense of fertilizing the first year in the regenerating treatment, may be valued with bisulphide of carbon at twenty-four dollars per acre. This first fertilizing will be followed, without designation of any fixed period, by suitable fertilizers, the net cost of which cannot be less than twelve dollars per acre each year.

Twentieth—The expense of fertilizing the first year in the regenerating treatment may be valued with the sulpho-carbonate of potassium at sixteen dollars per acre. This first fertilizing will be followed without designation of any fixed term, by suitable fertilizers, the net cost of which cannot be less than eight dollars per acre a year.

Twenty-first—On a general average, the inseparable association of insecticides and fertilizers will cost per acre: First year, for bisulphide of carbon, thirty-six dollars; for sulpho-carbonate of potassium fifty-six dollars. Following years: for bisulphide of carbon, twenty-four dollars; for sulpho-carbonate of potassium, forty dollars.

Twenty-second—These expenses are reckoned at the highest price, and would provide for a complete treatment of a nature to insure success. They will be notably less in many cases, especially when the applications are made at the beginning of the phylloxera invasion.

Twenty-third—Besides the preceding insecticides, sulphide of potassium appears to give favorable results. It would be well to study the latter more completely.

Twenty-fourth—In the absence of certain knowledge as to the way followed by the insects, who are creators of new colonies, or regenerators of the spent fecundity of underground aptera, insecticidal washing of the vine cannot be recommended as a surely efficacious means of protecting healthy vineyards, or of diminishing the multiplication on the roots. However, this practice appears to be a useful adjunct of the treatments. Complete and more demonstrative studies are yet to be made.

Twenty-fifth—No proved fact, no idea, authorizes us to foresee the downfall at short notice, or otherwise, of vineyards reëstablished or maintained in the conditions enumerated above, and which will be continually treated in this way.

Members of the Commission—Dr. Plumeau, President; Gayon, Regis, Richier, Paul Princeteau; Fallieres, Reporter.

[Translated.]

SUBMERSION.

First—Effected under perfectly determined conditions of season (from November to March), of duration, and of continuity of the sheet of water to be kept above the ground, submersion constitutes a sure means of preservation and restoration of vineyards.

Second—Submersion must be repeated every year.

Third—In the southwestern region, however, submersion appears to promote too vigorous vegetation of wood and leaves in varieties of tender wood, such as the *Malbec*, and consequently induces *coulure* at the time of florescence. On the contrary, varieties with hard wood, such as the *Mansin*, *Verdot*, and *Cabernet*, furnish more regular vintages.

Fourth—When submersion is executed with clear water, it appears to be advantageous to fertilize the vineyard periodically.

Fifth—When submersion is effected with muddy water, like the water of large rivers subjected to the periodical return of the tide, the settlings of the water seem to be sufficient to keep the vines in a proper condition of vegetation. However, perhaps it will be well, in order to promote fructification, to fertilize the vineyard annually with about eighty-eight pounds of real potash and about thirty-five pounds of phosphoric acid per acre.

Sixth—Nothing is more desirable than the adoption of general measures suitable to insure the benefits of this method to a great number of vineyards.

Members of the Commission—Dr. Plumeau, President; Gayon, Regis, Richier, Paul Princeteau; Fallieres, Reporter.

[Translated.]

PLANTATION IN SAND—AMERICAN VINES.

The French vine succumbs everywhere under the attacks of the phylloxera when it is not subjected to treatments of submersion or insecticides, whatever may be the nature of the soil, excepting, however, the extremely sandy soil.

The most energetic fertilizers and the most perfect cultivation may retard somewhat the destruction of the vineyard without, however, preventing it in the end.

Sand—Sandy soils, in certain given conditions of humidity, can present an insurmountable obstacle to the propagation of phylloxera; but that it may do so it is necessary for the sand to enter in the composition of the soil in a very considerable proportion. The insect has been found to exist in very large quantities in divers soils containing seventy-five per cent. of sand and eight per cent. of little pebbles.

RESISTANCE OF AMERICAN VINES.

American vines, whatever may be the varieties, possess, on the contrary, in divers degrees, a relative resistance that may even reach immunity. They should be considered as a sure means of reconstituting the vineyard.

Adaptation.—It is important, in selecting the American varieties for cultivation in each region, to pay great attention to the adaptatation, taking into consideration the climate, the humidity of the atmosphere, the nature and condition of the soil, exposure, etc.

Grafting Stocks.—American vines should, especially in the Gironde, be more especially utilized as grafting stock, that the same quality of wine may be produced as in the past. The best grafting stocks are the *Riparia* or its diverse varieties, and the *York-Madeira*; these two may be considered practically as phylloxera proof.

Grafting.—The grafting of French vines on American roots appears to us to be now an assured means of reconstituting our vineyards.

Grafting on stocks in the open fields gives the promptest and best results, and should be practiced when it succeeds in sufficient proportion. In the South, when consisting of simple cleft grafting on one year old stocks, it has succeeded in proportions varying from sixty to ninety-five per cent.

In the Gironde, grafting in the open field appears to have succeeded imperfectly as a general thing. It seems that grafting in the workshops on rooted stocks, the grafts then to be put in the nursery, should be preferred to the latter method.

Grafts are generally the English cleft, and the ordinary cleft on stocks one year old.

Considering the good results obtained in the South, the simple cleft graft, expeditious, and, in short, practical, deserves to be used in the Gironde.

The immediate planting of grafts made in the workshop before being put in the nursery, gives imperfect results.

Grafting a cutting on a cutting is of too limited success, and gives insufficient roots for it to be practiced advantageously by the proprietor.

Grafted vines bear earlier and perhaps will yield more.

Ligature and Sealing.—Ligature is generally effected with slightly sulphated raphia or with twine. Wet clay is the best thing for sealing.

Varieties Cultivated for Fruit.—Certain American varieties yield in sufficient quantity a good clean tasting wine, which may be blended advantageously with our ordinary wines.

The best varieties that are cultivated for fruit are the *Herbemont* and *Jacquez.* The *Herbemont* appears to be the chosen plant of the southwestern region; its vegetation there is more vigorous than in the South. The foliage is healthy and almost exempt from all cryptogamous growth. The fruit is abundant, sets well, and makes a wine superior in quality, but inferior in color and alcohol to that of the *Jacquez.*

The *Jacquez,* resplendent in the South, has in general suffered a good deal this year in the southwest from anthracnose and mildew.

The *Norton's Virginia* and *Cynthiana,* which it is difficult to distinguish, also grow very well in certain parts of this region, producing a wine of good quality and rare color. They will probably be cultivated, though bearing insufficiently, owing to the intense color.

The *Black-July,* not yet cultivated to a great extent, yields in sufficient quantity a grape of a brilliant red color and without foxy taste. It will probably be cultivated for fruit. The *Cunningham* ripens late.

Hybrids.—Among the hybrids, we must point out more particularly the *Othello, Brandt,* and *Canada* for red wines; the *Elvira, Noah,* ,and *Triumph* for white wines.

Members of the Commission.—Messrs. Lespiault, President; Piola, Vice-President; L. Gachassin, Secretary; Lafite, Reporter; J. Daurel, Escarpit, Millardet, Paul Skawanski, Froidefond, Delbruck, Ladonne, members.

CONCLUSIONS.

The evidence upon which the foregoing conclusions are based, will be quoted in extenso in the report of our Chief Executive Officer.

The conclusions of this committee are, viz.:

First—The phylloxera is not as much dreaded in California as in France, because it does not spread as rapidly, and because the isolation of most of our vineyards affords the greatest protection against contagion. To increase this protection we have vast areas yet unplanted where there is no disease.

Second—The comparatively small area of our vineyards as compared with probable future plantations, in which the experience of this and other countries will be of service to us, also renders the dangers to the industry insignificant.

Third—Being warned in time, excepting in a few places, where the disease has been permitted to progress unmolested, our vine-growers have little serious trouble to fear. With the death treatment of insecticides to infected spots as soon as discovered, the reconstitution of vineyards upon resistant stocks may be practiced gradually and without seriously impairing the productive profits of the industry.

Fourth—Isolation and vigilance in the disinfection of cuttings and rooted vines will probably preserve most vineyards until the time when replanting with resistant stocks will cease to be considered a burdensome expense, or until practical, cheap, and absolute methods of defense may be discovered and proved.

Fifth—Grafting upon resistant stocks should not be considered as grievous and burdensome expense. It will probably be discovered that independently of its value as a protection against phylloxera, the profits of the industry will be increased by grafting, inasmuch as the present evidence tends to show that the grafted vines bear earlier and more abundantly than the old vines on their old roots.

Sixth—There is no immediate danger of destruction of any vineyard not now seriously diseased. The possible necessity of reconstituting a vineyard that may be attacked will entail so little temporary loss of parts of the vineyard, that the evil need not be considered of great importance.

Seventh—In view of the great individual losses already suffered in certain places where the disease has been suffered to progress without hindrance, and in view of the reluctance of some wine growers to confess the presence of disease by making efforts to arrest it, it is of the greatest importance that all discoveries of infested spots should be made public as speedily as possible, thus putting at end all motives for concealment, and setting in motion efforts to arrest the evil. This principle has actuated this committee, and we believe it to be of the greatest importance to all concerned.

Eighth—With the aid of insecticides and American vines, we consider that the phylloxera question has been solved practically and economically. The great losses that have been suffered in France are due to the fact that the evil was spreading before the remedies were discovered and approved. We are indebted to French efforts for the information we now possess, enabling us understandingly to grapple with the difficulty as it appears.

Ninth—This Commission, or some other public body, should be more amply endowed by the State, with means to determine and demonstrate propositions of general interest to the public. We are dependent now more upon the work of other countries than upon our own. If it were not for the information we receive from France, our vineyards would have been doomed to destruction. Our work is so contracted for lack of sufficient support, that we have very little of value to communicate of our own original research in exchange for what we receive. Our present efforts are mainly directed towards obtaining and collating for our people what the public spirit of other countries offers us gratis, and in demonstrating the truth of their assumed discoveries. We have little left for original research.

I. DeTURK, Chairman,
GEORGE WEST,
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